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MONTHLY WEATHER REVIEW

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NOVEMBER, 1932

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THE CLIMATE OF THE LOWER RIO GRANDE VALLEY OF TEXAS [1]

By EDWIN J. FOSCUE

[Southern Methodist University, Dallas, Tex.]

Comparatively little detailed work has been done on the climate of extreme southern Texas and the region of the Lower Rio Grande Valley. Page (1) has given a complete discussion of the rainfall of southern Texas, but no similar work has been done for the section on the other climatic elements. Kincer (2) has made general studies which include this area, and in a more detailed way has described the climate of the Great Plains (3) which includes the Lower Rio Grande Valley. Descriptions of the climate of the valley have been written by Potts (4) and other descriptions are given by the authors of the soil surveys of Cameron, Hidalgo, and Willacy Counties. However, since most of the studies have been generalizations from the study of larger units or else very brief descriptions of the climate of the valley itself, it seems desirable to make more detailed maps and graphs for the valley proper and from these data to describe the climate of the area.

The Lower Rio Grande Valley lies in the Gulf climatic province, as described by Ward (5) and in the extreme southwestern part of the southern Texas region considered by Page. In general it is an area of very mild, almost frost-free winters, with a moderate rainfall, which decreases rapidly from the coast toward the interior. The large amount of sunshine and the high rate of evaporation due to the location of this area only a few degrees north of the Tropics, causes the rainfall to be deficient and necessitates the use of irrigation waters for agriculture.

The data used in making the maps and charts for this study were secured from: (1) "Climatological Data" (6); (2) "Bulletin W" (7), and (3) published and unpublished records of the United States Weather Bureau station at Brownsville, Tex. (8). With the exception of Brownsville, all of these are cooperative stations and their records are broken from time to time. Rainfall is reported more completely than any other item. By using the long time record for Brownsville as a base, and adjusting the variable records for the other seven stations on it, it has been possible to construct a rainfall map for a 60-year period for the entire valley region. The formula used in adjusting these rainfall data is the one commonly used.[2] The monthly rainfall records were not adjusted, but the actual averages for each station were used in making the charts. Temperature was reported less completely than rainfall, but averages were determined for each station and charted. Sunshine records were kept over an eight-year period for four of the stations, but, other than that, all additional climatological data were reported for Brownsville only. There is also included a three-year average of evaporation data from a temporary station at Mercedes. The following table gives the general information in regard to the eight stations used in this study. The locations of these stations are shown on the rainfall map.

Station	County	Elevation, in feet	Length of record
			Years
Brownsville	Cameron	57	60
Point Isabel	do	15	4
San Benito	do	37	9
Harlingen	do	37	15
Raymondville	Willacy	31	18
Mercedes	Hidalgo	66	16
Mission	do	140	14
Riogrande	Starr	168	18

RAINFALL

The rainfall of the lower Rio Grande Valley region shows a marked decrease from the coast toward the interior. The map of average annual distribution (fig. 1) shows a range from more than 30 inches on the coast at Point Isabel to about 16 inches at Riogrande, in a distance of only a little more than 100 miles. This range is still more striking when the level topography is considered. Riogrande is in fact only 153 feet higher than Point Isabel, but if it were at the same level, the difference in precipitation would likely be greater. Page (9) found a decrease of 28 inches between Beaumont and Brownsville in a distance of 400 miles, but this range is even greater with approximately 15 inches decrease for 100 miles. In discussing the causes of this marked decrease in rainfall, Page (10) gives the following causes:

(1) The southwestern part is more out of the southerly moisture laden winds.

(2) The southwestern portion is more in the horse-latitude high-pressure belt for a larger part of the year, and therefor less often influenced by extratropical storms.

(3) Fewer tropical disturbances affect the southwestern part, on account of its western position in the Gulf of Mexico, which places it out of the line of usual travel of these storms from their southeastern source.

While this great range in rainfall has an effect on the natural vegetation to some extent, its significance to agriculture is not as great as might be expected, since the evaporation rate is high enough to make even 30 inches of rainfall insufficient for successful agriculture, and irrigation is practiced throughout the region where topography and soils are favorable. The average annual rainfall, while varying in distribution throughout the region, is possibly not as significant as the variation in the annual total rainfall. This is illustrated by the chart (fig. 2) of the Brownsville station with its variability over

[1] This article is an excerpt from a doctor-of-philosophy dissertation submitted at Clark University, Worcester, Mass., in April, 1931.

[2] Formula:

$$\frac{\text{Total rainfall for short record station (same years as short record station)}}{\text{Total rainfall for long record station (same years as short record station)}} = \frac{x}{\text{Total rainfall for long record station (60 years).}}$$

x = adjusted total for short record station for 60 years.

$\frac{x}{60}$ = adjusted annual rainfall for the short stations.

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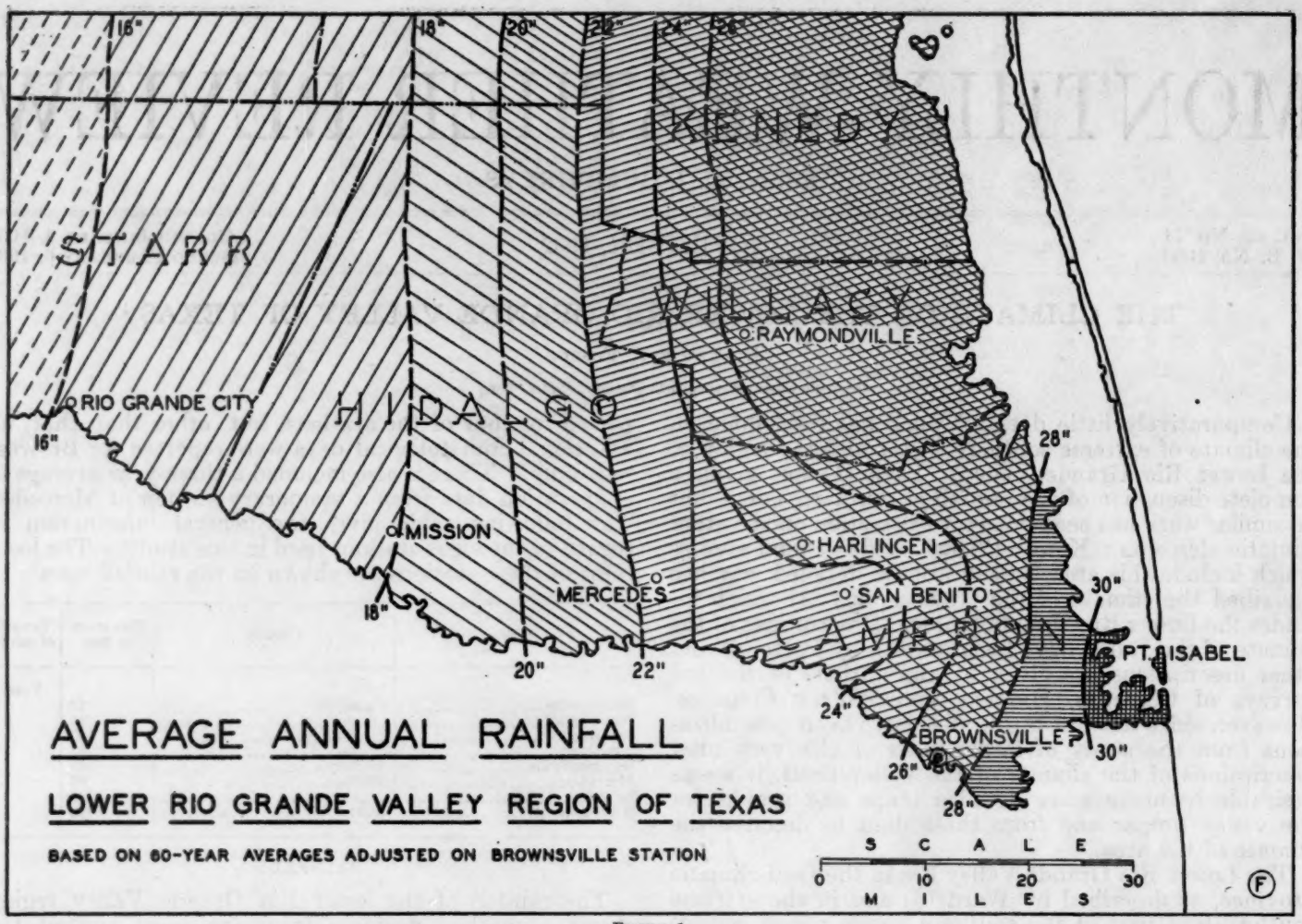

FIGURE 1

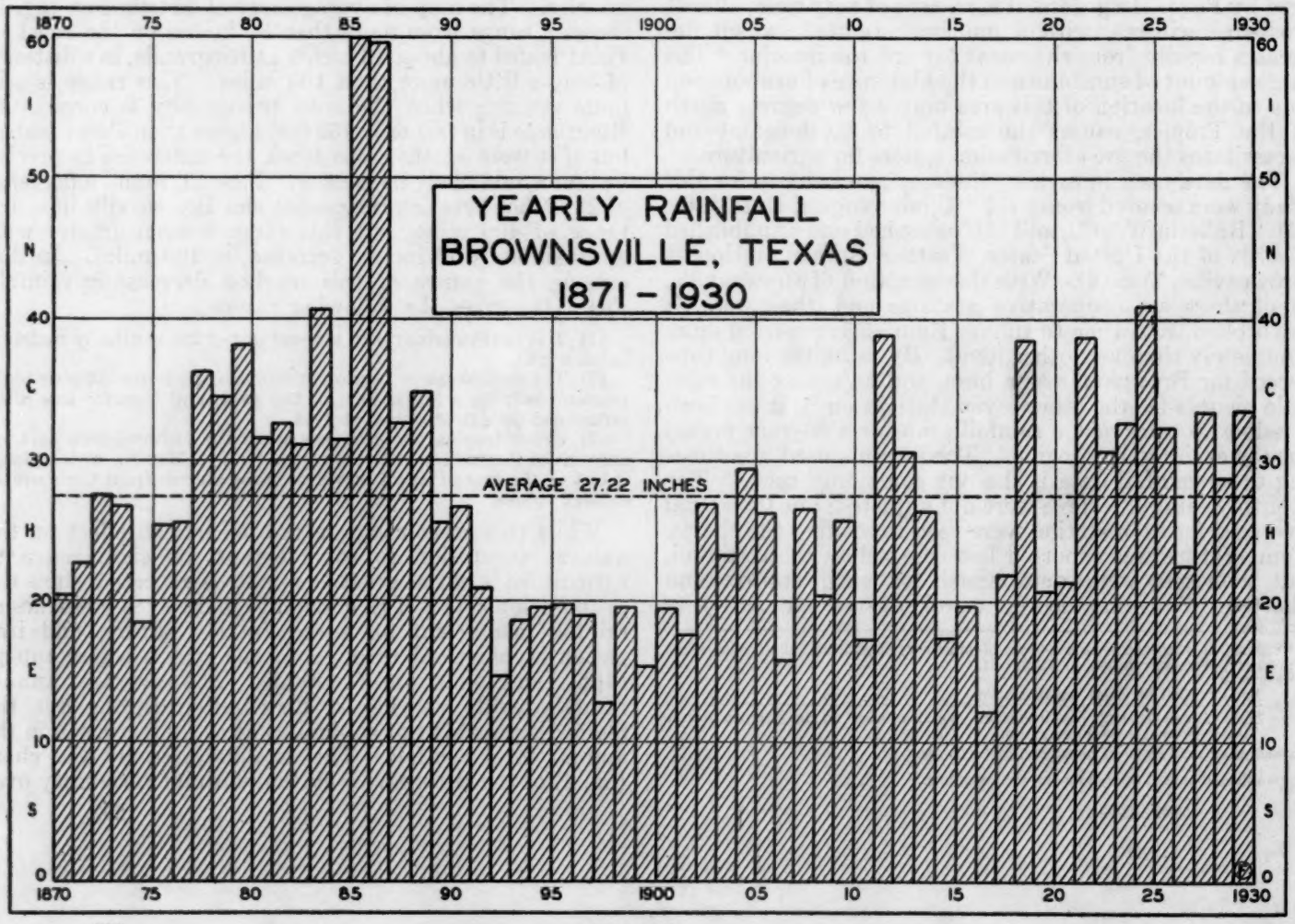

FIGURE 2

a 60-year period. With an average rainfall of 27.22 inches, Brownsville frequently suffers from periods of drought, which sometimes extend over a long period of years. The longest period of drought was during the years 1893 to 1902. During this 10-year period the rainfall did not total as much as 20 inches in any one year. Since this was before the development of irrigation in the valley, the crops that had been fairly successful during the wet decade preceding 1893 were failures. This protracted drought led to the development of irrigation, as it convinced the farmers that continued agriculture without it was impossible.

Records for the period show that the cattle industry that dominated the valley region before 1904 also suffered severely from this drought and many thousands of head died. A second drought period was from 1915 to 1917, but as irrigation was well developed by that date, there was not the inconvenience and loss from crop failures as was experienced during the earlier dry period. Kincer (**11**) notes both of these dry periods in his charts for the three sections of the Great Plains. The period from 1878 to 1887 was characterized by unusually heavy rainfall. Every year during that period had more than 30 inches of rainfall, and two years, 1886 and 1887, reached the high values of 60.06 inches and 59.82 inches, respectively. Since 1922 the rainfall for every year, except 1927, has been above the average. The absolute range in annual rainfall varies from 60.06 inches in 1886 to 12.15 inches in 1917. While detailed data for the other stations are not available for this long period, their variations are similar, and for that reason Brownsville may be taken as the type station. This tendency for periodic variations of rainfall is characteristic of the entire plains region and has had a great influence on agricultural development.

The chart of average monthly distribution of rainfall for the eight stations of the Lower Rio Grande Valley (fig. 3) shows a marked similarity in the course through the year. While there are local variations, the dominant feature of the rainfall of this region is that all stations are in the same rainfall region, which shows two pronounced periods of maximum precipitation. The first maximum comes in late spring, April to June. The second maximum usually comes in September, but sometimes in October. This September maximum is quite typical of the Texas coast, and has been called the "Texas coast type" by Ward (**12**). Tannehill (**13**) explains these two periods of maximum rainfall as follows:

> The prevailing southeasterly wind over Texas is in the nature of a monsoon, and its advance and retreat in May to June and September to October, respectively, are attended by increased intensity of rainfall, undoubtedly because of the attendant shift in wind direction.

The prevailing wind direction over Brownsville for a period of eight years shows a dominance of southeast winds for the spring months and again for the late summer months. From November through January the prevailing winds are northwest, and during that period the least rain falls over the valley. This is of great value to agriculture, as the mid-winter season is the period of maximum harvest for both fruit and truck and heavy rains during that time would seriously handicap the industry.

Of slight interest is the maximum variation in monthly precipitation. The absolute maximum of all of the stations is 19.21 inches at Brownsville in September, 1925, 10.44 inches falling during a 24-hour period. As to the minimum, practically every station has experienced rainless months.

HUMIDITY AND EVAPORATION

The average relative humidity at noon at Brownsville is shown in Figure 4. There is a very slight variation between summer and winter. The months of lowest relative humidity follow the months of maximum rainfall. Of more significance than the relative humidity of the region is the amount of evaporation. The only evaporation data that have been collected in the valley were worked out by the United States Department of Agriculture during a 3-year period from August, 1917, to July, 1920, inclusive, at Mercedes, Tex. The results of this experiment are given below (**14**).

Average evaporation for 3-year period (in feet)

Month	From a 5-foot tank	From a 2-foot tank	From a 1-foot tank
January	0.395	0.481	0.505
February	.264	.367	.664
March	.574	.570	.817
April	.658	.898	.996
May	.786	.942	1.016
June	.687	.812	.906
July	.745	.894	1.057
August	.813	.889	1.226
September	.651	.784	1.064
October	.488	.684	.706
November	.340	.616	.494
December	.376	.348	.655
Total	6.777	8.285	10.126

This table shows a great range in the evaporation rate between winter and summer for all three sizes of tanks. The August evaporation is more than twice that of the January rate. The total for the three tanks also show an evaporation rate of 6 to 10 feet, or about 75 to 125 inches. Since most of the irrigation ditches that have been constructed in the valley in the past are of the open type, this high rate of evaporation causes a heavy loss of the water that is diverted from the river into the ditches. This has led in recent years to the development of smaller main canals and covered laterals.

CLOUDINESS

Due to the fact that sunshine data are not kept by some of the stations of the area,[3] only four stations could be used on a comparative basis and these are for an average of only eight years. The number of days reported as clear, partly cloudy, and cloudy are given below:

Station	Clear	Partly cloudy	Cloudy
Brownsville	134	138	93
Harlingen	236	70	59
Mercedes	187	69	109
Raymondville	162	132	71

SUNSHINE

From the files of the United States Weather Bureau at Brownsville, additional data were obtained as to the per cent of possible sunshine at that station. Figure 5 shows this information in graphic form. While detailed statistical information is lacking for a study of this topic, the total amount of sunshine is quite large, especially during the winter season, and this, coupled with the mild

[3] There is but one sunshine station in this area, namely, Brownsville. Cooperative stations report only clear, partly cloudy, and cloudy days.—*O. L. Fassig.*

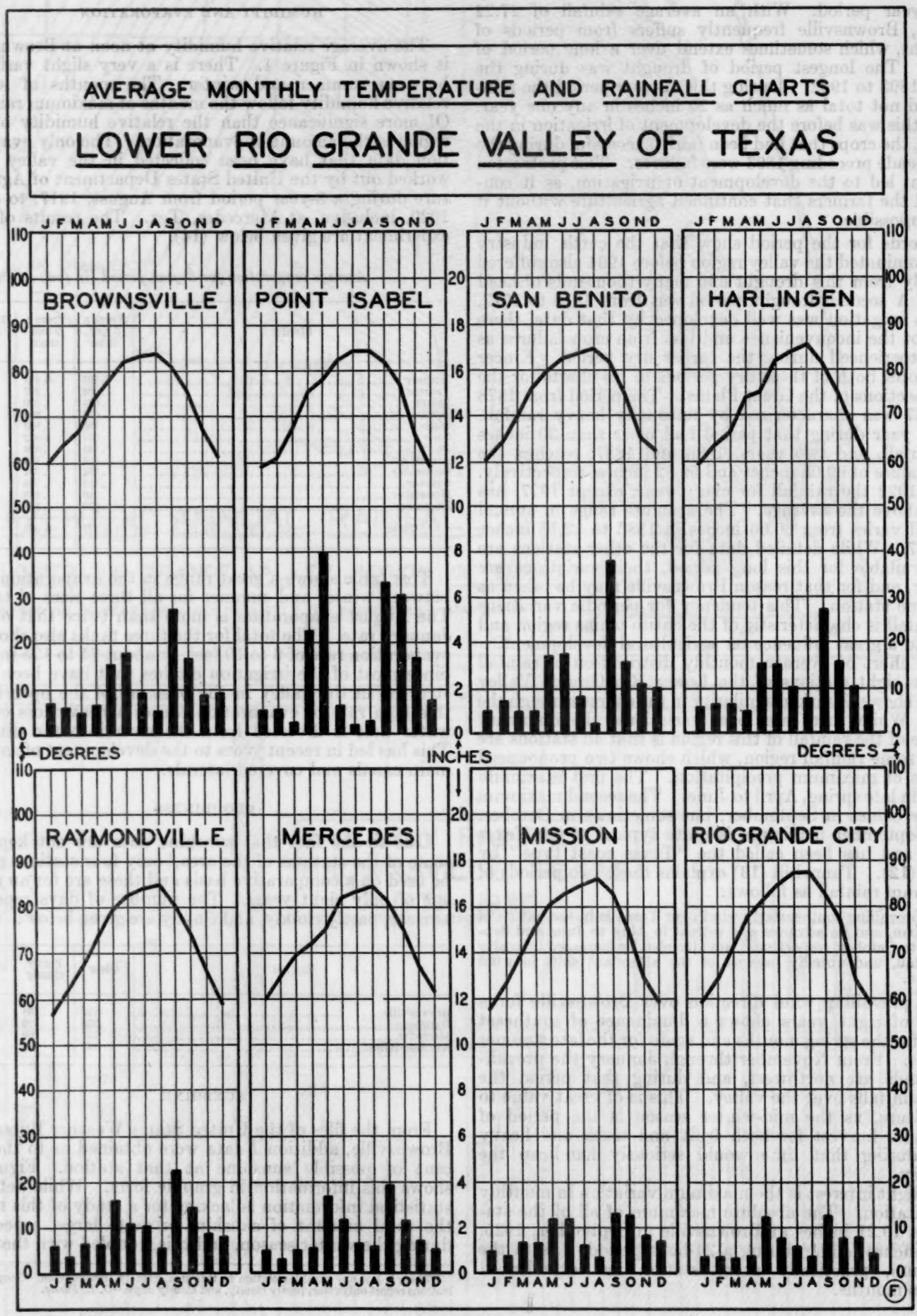
AVERAGE MONTHLY TEMPERATURE AND RAINFALL CHARTS
LOWER RIO GRANDE VALLEY OF TEXAS
BROWNSVILLE
POINT ISABEL
SAN BENITO
HARLINGEN
RAYMONDVILLE
MERCEDES
MISSION
RIOGRANDE CITY
J F M A M J J A S O N D
DEGREES
INCHES
F

FIGURE 3

winter temperature, is a great asset to the area in attracting winter tourists as well as in aiding the harvesting of crops.

WINDS

The winds of the Lower Rio Grande Valley are prevailingly from the southeast, particularly during the summer season. This not only brings heavy rainfall during that season, but also tends to reduce the temperatures. The average annual wind directions for Brownsville for morning, noon, and evening, over a period of eight years, is shown in the wind roses. (Fig. 6.)

The seasonal changes are shown by the monthly frequency wind roses for Brownsville. (Fig. 7.) From February to October, inclusive, the winds are dominantly from the southeast. November, December, and January

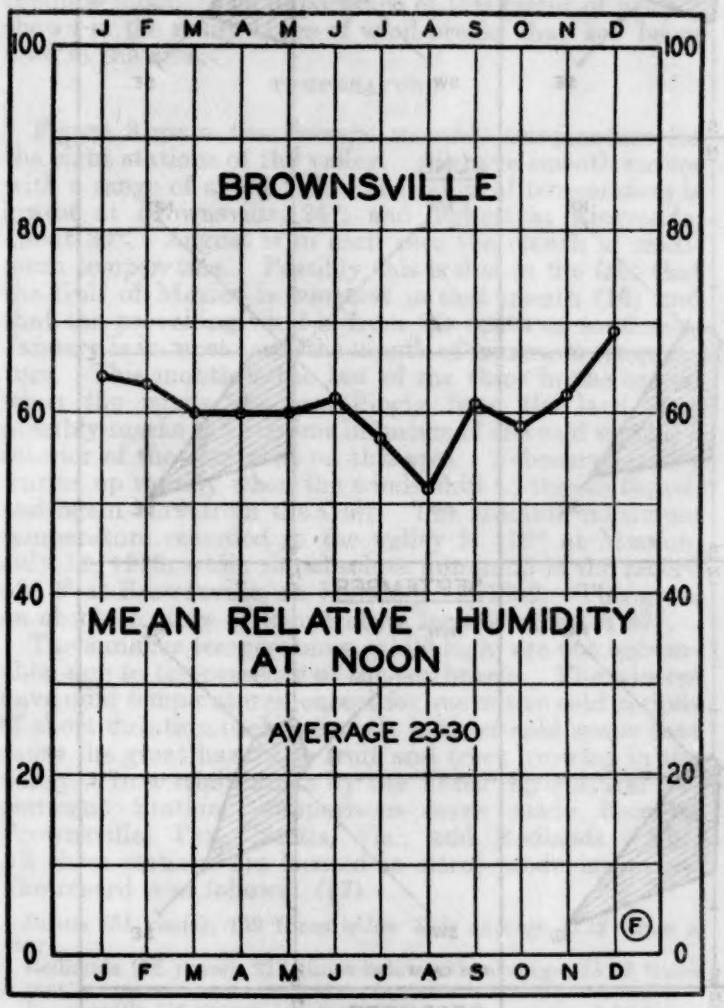

FIGURE 4

have a larger number of winds from the north and northwest than the other nine months. During these three winter months, though the winds are prevailingly from the north and northwest, the frequency of southerly winds is almost equal to that of the northerly winds. By February there is a marked diminution of the northerly winds, and an increase of southerly and southeasterly winds. In April the north and northwest winds become negligible and do not again assume importance until September. They increase during October, and become prevailing during November. The table below gives the prevailing wind direction for each month of each year from 1923 to 1930, inclusive. (15)

Month	1923	1924	1925	1926	1927	1928	1929	1930
January	S.	N.	N.	N.	S.	S.	N.	NW.
February	S.	S.	S.	S.	SE.	SE.	NW.	SE.
March	S.	S.	S.	S.	S.	S.	S.	SE.
April	S.	S.	SE.	SE.	S.	S.	SE.	SE.
May	S.	S.	SE.	SE.	S.	S.	SE.	SE.
June	SE.	S.	SE.	S.	S.	S.	SE.	E.
July	S.	S.	S.	S.	S.	SE.	SE.	SE.
August	S.	S.	S.	S.	S.	SE.	SE.	SE.
September	S.	SE.	S.	SE.	SE.	N.	SE.	SE.
October	N.	N.	S.	S.	S.	SE.	SE.	E.
November	N.	S.	N.	S.	S.	N.	NW.	S.
December	S.	N.	N.	S.	N.	N.	SE.	NW.

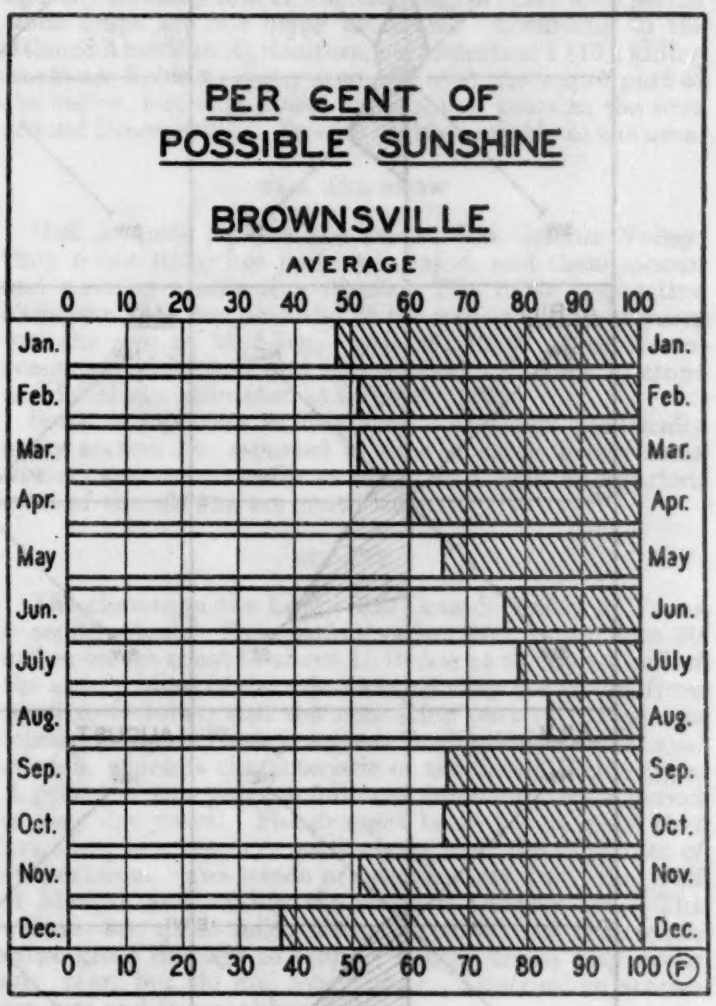

FIGURE 5

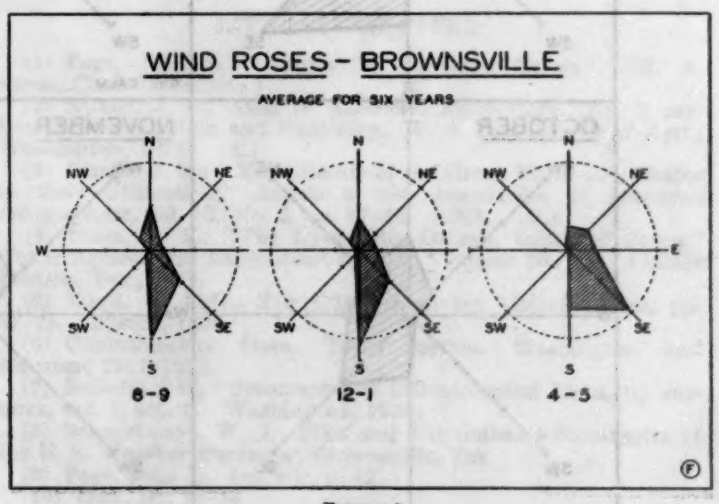

FIGURE 6

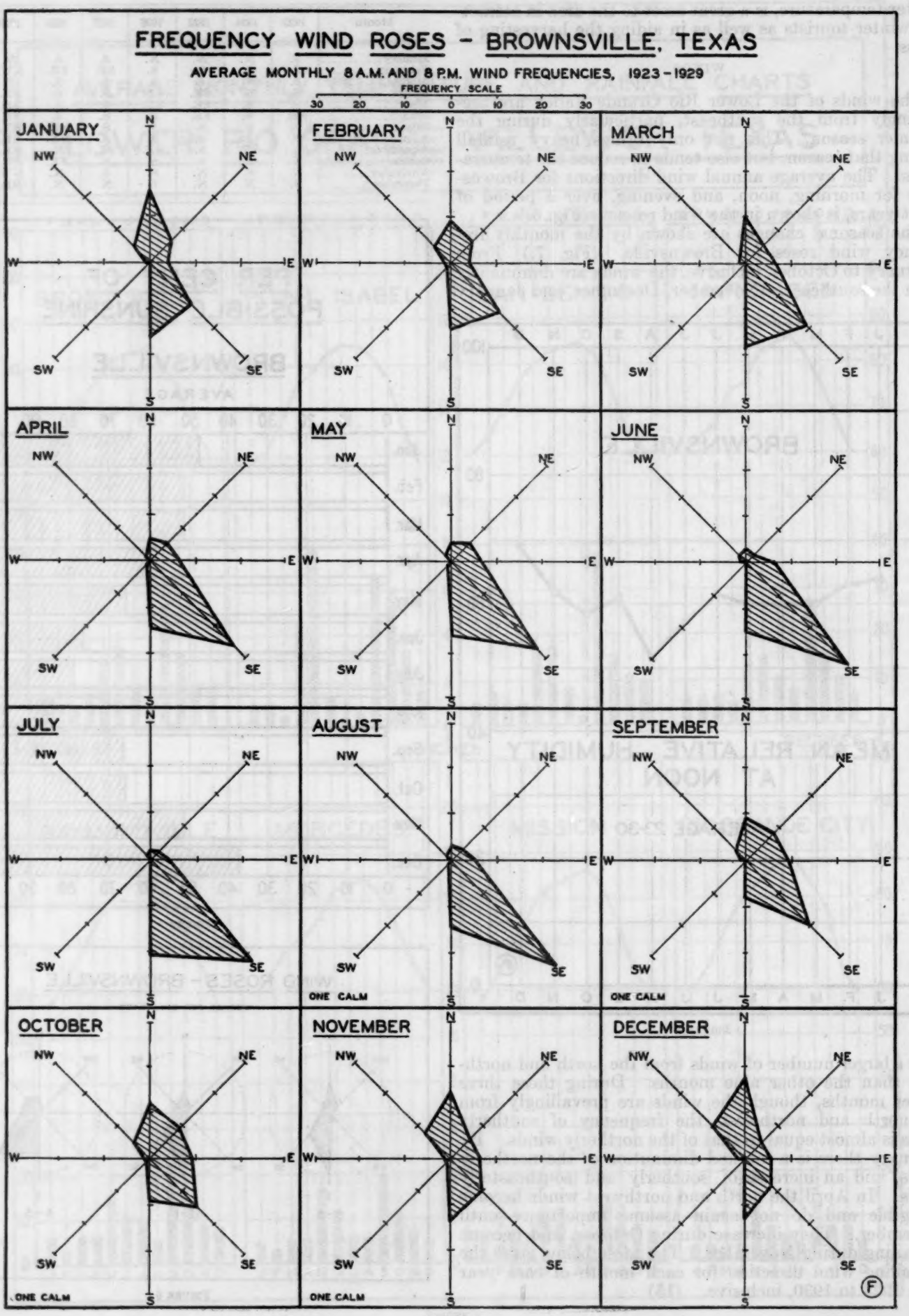
FREQUENCY WIND ROSES - BROWNSVILLE, TEXAS
AVERAGE MONTHLY 8 A.M. AND 8 P.M. WIND FREQUENCIES, 1923-1929
FREQUENCY SCALE
30 20 10 0 10 20 30
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
N
NE
E
SE
S
SW
W
NW
ONE CALM
F

FIGURE 7

There is a slight variation in the prevailing monthly wind direction from year to year, but this variation is not of significance.

The prevailing wind direction therefore exerts a continental influence in the valley from November through January and produces a marine effect during the remainder of the year. The highest recorded wind velocity at Brownsville was 44 miles per hour, October 20, 1926. This was a north wind. While the absolute maximum wind velocity is not high, the average wind velocity is by no means low, particularly during the period of the "norther." This relatively stiff wind, coupled with subfreezing temperatures, is a great handicap to the citrus industry in that it makes the smudging of orchards of little value, as the wind will carry the smoke and warm air out of the orchard as fast as the orchard heaters can produce them. The importance of this factor of wind is shown in the many types of wind-breaks that are being used in the area.

TEMPERATURE

Figure 3 gives the average monthly temperature for the eight stations of the valley. All have smooth curves with a range of about 25°. The range of temperature is lowest at Brownsville, 24°, and highest at Riogrande, about 30°. August is in each case the month of maximum temperature. Possibly this is due to the fact that the Gulf of Mexico is warmest in that month (16) and that the prevailing wind is from the south or southeast. January is in most cases the month of minimum temperature. This month is the last of the three in the season when the winds are prevailingly from the land, and possibly marks the extreme influence of the cold northern interior of the continent on this area. February usually warms up rapidly when the winds shift to the southeast, and again blow from the Gulf. The absolute maximum temperature recorded in the valley is 110° at Mission, July 12, 1923, while the absolute minimum is the record of 12° at Brownsville, on February 13, 1899. This gives an absolute range of temperature for the valley of 98°.

The summer temperatures, while high, are not unbearable, due to the presence of the sea breeze. The winters have mild temperatures, except for one or two cold periods of short duration each year. It is these cold snaps that cause the great hazard to fruit and truck growing in the valley. In a study made by the Texas Agricultural Experiment Station, comparisons were made between Brownsville, Tex., Eustis, Fla., and Redlands, Calif. All three stations are located in citrus-producing areas. The record is as follows: (17)

Eustis (31 years), 159 times below 32°; average, 5.12 times a year.

Redlands (16 years), 218 times below 32°; average, 13.62 times a year.

Brownsville (28 years), 101 times below 32°; average, 3.52 times a year.

From these figures it seems that the Lower Rio Grande Valley is more favored than either of the other two areas, but, on the other hand, neither of them have had as low a temperature as Brownsville. However, the actual temperature is not as significant as the duration of the cold spell below the freezing point. In a study of the probabilities of recovery from subnormal temperatures along the Texas coast, Tannehill (17) found that the probability of a rise increases as the temperature falls, and that there is a 44 per cent probability of a rise of more than 10° at temperatures between 20° and 28°.

Most of the cold waves or "northers" that reach this section with subfreezing temperatures are of the dry norther type and are frequently accompanied by high winds. If the wind dies down, severe freezes are likely to occur. In the valley area most of the "wet northers" do not have freezing temperatures. Tannehill (18) found that severe wet northers, with more than two days of freezing temperatures, occurred at Galveston about once in three or four years. The probability of their occurrence should be even less than that in the Lower Rio Grande Valley, which is south of Galveston by nearly 4° of latitude.

The length of the growing season is rather difficult to figure. Actually it is 12 months long, as there is no period when crops are not being produced. According to the Atlas of American Agriculture, part 2 section 1 (19), killing frosts are liable to occur annually over the upper part of the valley, but only about once in two years in the area around Brownsville. Frost is highly variable in the area.

HAIL AND SNOW

Hail is quite rare in the Lower Rio Grande Valley. Only a few times has hail been noted, and these storms had no very destructive effects. The most destructive hailstorm that has occurred in the valley in recent years was the one at McAllen, April 29, 1930. This storm, accompanied by hail and rain, caused a damage to crops and buildings estimated at $50,000. (20)

Snow is also rare in this area. Although practically every station has reported a trace of snow during some winter, and occasionally as much as 1 inch is reported, most of the winters are snowless.

SUMMARY

The climate of the Lower Rio Grande Valley of Texas is semitropical. The rainfall varies from more than 30 inches on the coast to about 15 inches at the upper end of the area. Most of the rain comes during the period from April to October, and the remaining part of the year is relatively dry. There is a great fluctuation in the annual rainfall, which is characteristic of the Great Plains type. A period of wet years is followed frequently by a period of very dry years. The drought hazard is so great that irrigation is necessary, particularly with the high rate of evaporation. The winds are dominantly from the Gulf of Mexico, and modify the summer temperature. The winters are quite mild, although occasional cold spells cause great damage to crops. Killing frosts may occur any year, but do not every year. Destructive storms are rare and snow seldom falls.

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AERONAUTICAL METEOROLOGY IN GERMANY

ERIC R. MILLER
[Weather Bureau office, Madison, Wis.]

The following account of the work of the German national meteorological flying stations is taken from nine papers by Kurt Wegener, A. Lohr, H. Steinhaeusser, H. O. Steiner, P. Lautner, and K. O. Lange that were read at one of the periodical meetings of the members of the service held at Hamburg on April 24–26, 1930, and subsequently printed in the Meteorologische Zeitschrift, volume 47, September 1930, page 325–345.

Daily airplane flights are made at Berlin, Hamburg, Darmstadt, Munich, and Koenigsberg. The ships and pilots belong to the national school for commercial pilots. The meteorological work is under the Imperial Ministry of Commerce.

The object of the flights is primarily the supplying of information for the benefit of air commerce, but experimental and research meteorology and the testing of aeronautical instruments are provided for by attaching a trained meteorologist to each ship. The resulting benefit to the meteorologists has been so great that it is proposed to make experience in the high meteorological ascents a prerequisite for all who have to do with issuing meteorological information to aircraft.

The flights are made simultaneously, to at least 5,000 meters (and a maximum of 7,360 meters has been attained. The peak altitude is timed to be reached at 8 a. m. Central European time when the observers on the ground are making the observation for the synoptic map. After the descent the results have to be reduced in time to be broadcast by radio at 10 a. m.

The daily flights were begun in April, 1927. During the year 1928 high flights were made on 86 per cent of all available flying days; in 1929 on 98 per cent. At Hamburg 45 per cent of the flights were "cloud flights" on which neither the ground nor the horizon was visible and it was necessary to rely on the gyroscopic level.

For the sake of quick reduction of the record sheets from the meteorographs, the ascent is made at an unchanging rate. Inversions are depended on to connect the different traces on the sheet. Sounding balloon observations have been used to check the results of the airplane records. The first extensive series of such comparisons during the international observations of December, 1929, showed not only satisfactory correspondence of both temperature and humidity, but showed that the airplane meteorograph gave more detail on account of its more open scale.

The structure and transformations of clouds and their relation to the movements of the air masses of the Bjerknes polar front theory have been an important concern of the observers, and many important relations have been derived from observation. For example, "if the lower boundary of a continuous cloud sheet consists of fracto-stratus or fracto-nimbus then an airplane can emerge from the cloud sheet in descent without great danger, because the existing turbulence of the ground air layer always provides for the breaking of the lowest cloud zone.

"If a warm air wave comes in on the front of a depression, it is almost always indicated a day before by a formless haze in the southwest sky, while toward the other quarters of the sky the old air masses appear clear."

Some new cloud forms discovered on the high flights have received the names of their discoverers, viz, "Wegener air waves," "Lohr cloud stripes."

Thunderstorms are found to be observable at much greater distances, some as far away as France, Switzerland, and the North Sea. Studies of the vertical currents in and around cumulus show upward velocities of 2 to 4 meters per second; in cumulo-nimbus, 10 to 15. In front of line-squalls strong vertical bumpiness extends 3 to 4 kilometers, but this vanishes directly over the squall roll, and the space behind the squall head is very smooth. Further details regarding flights in clouds are contained in MONTHLY WEATHER REVIEW, November, 1931, pages 430 and 431.

Icing of airplanes has been a particular object of research. On 150 flights at Koenigsberg icing occurred on 16. The worst case was on December 17, 1929. After 9 minutes the temperature having fallen to −9.8° C., the machine was suddenly covered with ice that reached a

thickness of 3 centimeters (1.2 inches). The unbalanced propeller threatened to tear the engine out of the ship, so that the pilot was forced down, but brought the plane under control at 300 meters above the "Haff" or lagoon, where the temperature was 3.2° C., and the ice melted off in flight.

The results of observation of icing of ships are summarized by Steiner as follows: Ice forms on airplanes (1) in tropical moist air, but not in continental warm air nor in purely polar air; (2) on leading edges of propellers and wings, etc., and spreads backward; (3) in temperatures of 0°C. to −24°C.; −6°C. to −12°C. are the most dangerous temperatures; (4) in isothermal as well as inversion clouds; (5) in gradients up to 0.9°C. per 100 meters; (6) only when the cloudy air is saturated with reference to water; (7) dependence on size of drops was not ascertained; (8) time of flight in cloud ranged from 1 to 25 minutes.

One respect in which the older kites and balloons are superior to airplanes is the observation of wind, provided the sky is clear. In and over clouds some progress has been made by range finding on audible signals from explosions and on radio signals from a radio transmitter. Steinhaeusser, at Darmstadt, has been experimenting on estimates from the drift of airplanes determined by radio.

Oxygen-breathing apparatus has been the object of much experiment in the German aerological flights, but has been given up in routine work. The observers' objections are that the expanding oxygen freezes the tongue and teeth, and that they do not feel free enough for work or for a parachute jump when attached to the apparatus by strings and tubes. Nausea follows exposure to the thin air of high altitudes after some hours. The first effect of descent to normal pressure is a stimulation that enables the observer to get through the strenuous work of reducing his observations in time for broadcasting.

Atmospheric electricity is proposed as a subject for regular observation both with reference to thunderstorm electricity and the normal electrical state of the atmosphere. The latter observations are especially difficult in an airplane because the machine is kept highly charged by the exhaust. An instrument devised by Idrac is available for use either at the end of a long line or to be dropped in a parachute. The importance of the subject has only recently been realized through research on the relations of haze, cloud, and precipitation to the ionization potential gradient, mobility of ions, and other subjects hitherto considered only in the laboratory of colloid chemistry.

Quantitative measurements of thunderstorm electricity are also proposed, and the advice of Benndorf and Wigand, has been promised.

For photography the airplanes are equipped with a 25-centimeter (10-inch) airplane camera. The photographs obtained are of interest to the meteorologist, the airplane pilot, and for school instruction. Clouds naturally come in for the greatest share of attention. The narrow outlook between the wings, the vibration of the engine in ascent, and the fogging of the chilled lenses in descent introduce unusual difficulties.

Another German institution that is contributing to meteorology in an entirely unique way is the research institute of the Rhoen-Rossitten Association. The association is promoting sailing and gliding flight as a sport by providing flying fields, annual competitions, etc. The institute is taking advantage of the opportunities that such flight affords of obtaining scientific insight into the aerodynamical and meteorological conditions requisite for air transport of all kinds.

The following account of the institute is drawn from a paper by the director, Dr. Walter Georgii, Ten Years Gliding and Soaring in Germany, (Quarterly Jour. Roy. Met'l Soc., v. 56, Apr., 1930, p. 141–150), from the annual report for 1929 of the director, and a review of this report by Sir Gilbert T. Walker, in the Quarterly Journal for July, 1931 (v. 57, p. 340–344).

The work of the institute on the design of aircraft and on flight technique will not be discussed here, but the work on vertical currents, especially under cumulus clouds and in storm fronts, will be outlined.

There have been three stages in the development of the sport of gliding and soaring. First came the use of local rising currents over every irregularity of the earth's surface; e. g., knolls, dunes, woods, even the waves of the sea may be used for soaring flight. The work of the association is centered around two well-known soaring grounds, the Wasserkuppe on the Rhoen hills east-northeast of Frankfurt and Rossitten on the sandy coast of eastern Prussia.

Increasing familiarity of pilots with the local conditions around these hills enabled them to increase the duration of soaring flight from 2 minutes 22 seconds and 1,830 meters length on the first flight by Klemperer in 1920 and 1 hour by Hentzen and Martens in the *Vampyr* in 1922 up to 8 hours 24 minutes by Neininger at Wasserkuppe and 14 hours 43 minutes by Dinort at Rossitten in 1929.

The second stage of advance was the use of ascending currents under cumulus clouds. These free pilots from the local topography and enable them to undertake cross-country flights.

The technique may be illustrated by one example: Kronfeld started from the western slope of the Wasserkuppe and flew at once toward an approaching cumulus cloud, which he followed toward the east with continual gain of height, reaching finally 470 meters above the starting point. The cloud began to dissipate and the up current became ineffective, so that Kronfeld left it at once and flew with considerable loss of height to the Himmelsdankberg, the turning point of the official course, and then, flying always from cloud to cloud, he returned to the Wasserkuppe at his maximum height of 540 meters above the starting point. Further development may be measured by the following instances: On July 30, 1929, Groenhoff, with a passenger in the 2-seater glider *Rhonadler* flew under a cumulus and rose through it almost to its summit, reaching a maximum altitude of 1,250 meters above the starting point and then flew a course of 33.3 kilometers. On the same day and under the same conditions Kronfeld was carried up to 2,150 meters and made a cross-country flight from Wasserkuppe to Bayreuth, 150 kilometers, in 4 hours.

The third and most recent development has been the use of up currents in front of line squalls. In the longest of these flights Kronfeld started at the moment when the wind was freshening just before the arrival of the line squall, and, by utilizing the rising current just before the cold front, rose 2,000 meters. He then flew about 2 kilometers in front of the squall, rising or falling slightly as he was nearer or farther from the front. He finally turned away from the front and landed 143 kilometers away from the Wasserkuppe after four and one-half hours flight.

It is in the scientific study of the phenomena revealed by the flights that the institute is doing such important work. For this purpose light airplanes have been built, with engines as small as 8 horsepower. The normal rate

of ascent and the falling velocity of these has been determined, so that placing the plane in any given situation enables the upward current to be determined. Measurements have been effected up to 4 kilometers, and enough material has been accumulated to enable general conclusions to be derived as to the intensity, vertical extent, and the cause of vertical movements in relation to heat conditions, vertical distribution of horizontal wind velocity, and weather conditions.

Doctor Raethjen, whose health has now given way, developed an extraordinarily accurate kinematographic measuring apparatus for following from two bases the flight of a soaring plane or small balloon.

In the study of streamlines in the free atmosphere, pilot balloons with no lift are carried up by airplane and released at definite places. This work is being extended to the study of turbulence.

The work of the institute is being greatly handicapped by the present financial situation in Germany. The subsidy from the State was reduced one-third in 1929, and three of the scientific posts had to be allowed to lie vacant.

METEOROLOGICAL CONDITIONS DURING THE FORMATION OF ICE ON AIRCRAFT[1]

By L. T. SAMUELS

[Weather Bureau, Washington, D. C., Dec. 1932]

(Author's abstract)

Ice is found to collect on a plane in appreciable amounts only when the plane is in some form of visible moisture such as cloud, fog, mist, rain, etc., and the air temperature is within certain critical limits. There are two principal types of ice formation found under such conditions, viz, clear ice and rime. Of these, clear ice forms the greatest hazard in that it adheres more firmly to the plane and decreases its lifting qualities markedly. A third type, viz, frost, is of lesser importance, as it has very little resistance to the vibration and wind force encountered in flight.

The records of ice formation obtained at four Weather Bureau airplane stations were classified according to the two general types of formation, viz, clear ice and rime, together with the respective temperatures, relative humidities, clouds and elevations above ground at which the formations occurred. This classification includes 108 cases where rime formed, 43 cases in which clear ice formed and 4 cases when both rime and clear ice formed during the same flight.

It is found that both clear ice and rime formed over practically the same range of temperature, viz, 0° C. to −18° C. and 0° C. to −20° C., respectively, showing that temperature alone can not be used as a criterion for indicating which type of formation will occur on any particular occasion. It is thus concluded that one or more other factors are decisive in determining the type deposited.

The temperatures at which the most frequent deposits occurred were higher for clear ice (−4° C. to −5° C.) than for rime (−6° C. to −7° C.). These values agree closely with those found by Peppler (1) from kite observations. The latter indicated that clear ice formed at an average temperature of −4° C. and rime at −6° C. It is found that 58 per cent of the total number of clear ice formations occurred at temperatures at or above −5° C., whereas only 37 per cent of the total number of rime formations occurred over this temperature range.

A very pronounced maximum frequency of occurrence of both clear ice and rime was found at relatively low heights, viz, between 500 and 1,000 meters above ground. Secondary maximum frequencies were found between 2,500 and 3,000 meters for clear ice and between 4,000 and 4,500 meters for rime. These primary and secondary maximum frequencies of occurrence are possibly related to layers of maximum condensation (cloudiness). Both types of formation occurred throughout the same strata and with small and practically equal percentages of frequency at the lowest and greatest heights reached. The maximum heights where icing occurred coincide with the maximum heights of the flights.

Both clear ice and rime formed most frequently in St. Cu. clouds. Comparatively high percentage frequencies of clear ice formations occurred in A. St. clouds, and of rime in St. clouds; when in rain, but not in cloud, the formation was always clear ice.

An examination of the prevailing temperature lapse rates occuring in these observations showed no relationship between the lapse rates and the type of ice formation.

The ratios between the number of occurrences of rime and of clear ice deposits vary considerably for the four stations used. This ratio for the observations for all stations combined was 2.5 to 1.0, with a preponderance of rime. These ratios (rime: clear ice) for the individual stations are as follows: Chicago, 1.7; Cleveland, 7.5; Dallas, 5.5; and Omaha, 0.6.

It seems probable that, in general, large droplets tend to form clear ice, whereas small droplets usually produce rime. Small droplets, in general, freeze more rapidly than do large droplets.

The resultant effects of partial freezing, evaporation, and rate of conduction of heat away from water deposits on the plane appear to be of prime importance in determining the type of deposit.

The suggestion by various authors that supersaturation with respect to ice in clouds composed of subcooled water droplets is responsible for comparatively sudden and heavy ice deposits as occasionally reported by pilots is shown by Humphreys (2) to be inadequate. If we assume a condition of supersaturation with respect to ice at a temperature of −10° C., and if all the excess vapor in the air were deposited on the plane, it would be equivalent to a layer of clear ice 1 inch thick on the front of a plane after the latter had flown for a distance of 72 miles. Furthermore, it is probable that only a small part of the excess vapor encountered would be deposited on the plane.

In connection with the occurrence of undercooled cloud droplets at low temperatures it is noted that A. Wegener (3) observed a "fog bow" in Greenland at −34° C.; also, W. C. Haines (4) observed rime formations in the Antarctic produced by fog at temperatures of −26° C., −30° C., and −44° C. The manner in which water exists in the liquid state at such low temperatures is not fully understood.

The results of this investigation show that the danger of ice formations can be avoided only by avoiding visible moisture, particularly liquid water clouds or rain, when the temperature is at or below freezing.

One of the chief difficulties in a study of this kind is the frequent impossibility of determining which type of

[1] Complete paper published by National Advisory Committee for Aeronautics Technical Note No. 439. Washington, D. C., 1932.

ice formed, since most of these flights were made before daylight and the ice usually was melted by the time the plane reached the ground. Also, there is a certain amount of confusion in the minds of many as to what constitutes rime and what clear ice. It is hoped that the descriptions given in the paper will make possible a more accurate classification in this respect in future observations. It is believed, however, that so far as averages are concerned, the values found would not change appreciably with additional observational data.

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THE SECTION DIRECTOR AND THE COOPERATIVE OBSERVER[1]

By M. E. BLYSTONE

[Weather Bureau office, Huron, S. Dak.]

I have chosen as the title of the paper, "The Section Director and the Cooperative Observer." This title would seem to involve practically all the activities of the Climatological Service, and probably nearly all of them will be touched upon in some part of the paper in the hope that some of my experiences and possibly some of the methods of handling the work at Huron may prove helpful to other section directors. There is also the hope that in the discussion to follow some things will be brought out that will be helpful to me. However, it will deal mainly with matters pertaining particularly to the personnel.

It seems to me that the most important functions performed by the Weather Bureau, next to that of making and disseminating forecasts and warnings, is that of securing a climatological history of the country. The aim of each section director, to voice a thought which, doubtless, every one of them has before him at all times, should be to make this history as exact and reliable as possible. In the aggregate, large interests are involved in this connection. Court decisions and the friendly settlement of damage claims are often determined by the weather records. Whether climatic conditions are favorable or unfavorable for the type of farming in which prospective settlers contemplate engaging is shown largely by the climatological history obtained through the efforts of cooperative observers. This is true of all the country, but it is particularly true of the more sparsely settled States like South Dakota.

It is as much the duty of the Weather Bureau to show that climatic conditions are unfavorable when such is the case as it is to show that they are favorable. Also, in some instances, the practicability of carrying on other industries than farming is determined by the climatic conditions that prevail. That justice may prevail in court decisions and in the friendly settlement of differences; that the development of agriculture, particularly in new territory, may be along proper lines; and that the peculiar climatic conditions needed by certain lines of manufacture or other industry may be determined so that they need not be artificially produced, thus avoiding economic loss, reliable data are necessary. Thus a great responsibility rests upon the section director and, through him, on the cooperative observers. Careful and conscientious direction of the work of cooperative observers by the section director can bring valuable results, while lack of it may bring loss to those placing reliance on the accuracy of the data. The thing of first importance in the service, therefore, is to secure a corps of intelligent and reliable observers, men or women, who take a personal interest in making weather records and can be depended upon to make them trustworthy and to whom anything other than truth in their records would be odious.

In what class of persons can the most desirable observers be found? This is a question that is difficult to answer. Probably section directors have varying opinions regarding the matter, based, of course, upon their varying experiences. First of all I want to eliminate schoolteachers. My experience is that they are undesirable. Their first purpose in acting as observers is to have the use of the equipment in teaching a small amount of meteorology to their science classes. This, in itself, of course, is good, but the purpose of maintaining the climatological service is to record climatological history, not to teach meteorology to high-school students. The teacher is apt to delegate the taking of observations to students, one at one time and another at another time, with undesirable results, for few of them comprehend the reasons for the work or care for it beyond getting by. Furthermore during vacation periods it is probable that no observations at all will be made.

It has been my experience that intelligent farmers of some education who possess a liking for noting and recording weather facts make excellent observers. Their personal interests are involved in securing a reliable climatological history of their localities. Also they are located out in the open where they can observe and make note of facts regarding the weather that are not so apparent to a man in town. If the equipment is properly placed on a farm, the data are less likely to be affected by local conditions than if the equipment is in town. When inspections are being made, some inconvenience is encountered and some additional expense is incurred if the station is in the country, particularly if the section director is traveling by train and not by automobile, and these facts deserve consideration. However, if a farmer who is acting as observer lives near town these considerations are minimized. On the whole I prefer farmer observers to any other class. When in need of a new observer my practice is to try to secure an intelligent farmer who lives near town and who is interested in that sort of thing. This is not to say that excellent observers are not found in other lines of employment. We have many excellent observers in South Dakota who are not farmers.

Probably every section director has, at some time or other, wished that cooperative observers were paid for their services so that pressure could be brought to bear on them to induce them to render prompt and complete reports. Doubtless, however, the attitude of the central office in this matter is wisest, for if no observer who is desirable because of his intelligence, reliability, and interest in the work can be secured without pay, the small compensation that could be given probably would not

[1] Invited paper presented before American Meteorological Society, Des Moines, Iowa, Dec. 28, 1929.

tempt him. The man who would act as observer for the few cents a day he would receive for his services and for that reason only, and who would have no other interest in the work, could not be depended upon to give the observations the careful attention they should have. Inaccuracies which he might believe would not be detected would mean nothing to him, while to the observer who does the work for love of it carelessness and inaccuracy would be repugnant. Probably every community has one or more persons who take pleasure in noting weather conditions and who would gladly act as observers, making excellent ones.

It seems to me that when a change of observers has become necessary or desirable the section director should visit the station, canvass the town and surrounding country carefully, and thus find the person best fitted to take over the work. This, of course, would be expensive, but it is my belief that the expense would be justified by the increased value of the climatological history secured. The data for cooperative stations, though less complete, should be as trustworthy as the data for the regular Weather Bureau stations. It can be made so only by the careful selection of observers. The expense would, partially if not wholly, be canceled by savings in other ways due to the operation of this plan. The total expense of the Weather Bureau for such visits and for inspection of stations might be reduced by visiting, en route, stations needing inspection. Also with observers thus carefully selected there would be less frequent need of inspection. Furthermore, it is probable that changes of observers would be less frequent than if they were secured through correspondence. The reliability of records, and consequently their value, that would be secured in this way would be greatly increased.

In connection with the expense of maintaining the climatological service the proportion of temperature and rainfall stations to rainfall stations should be given careful consideration. Temperature distribution is much more uniform than precipitation distribution. This is particularly true of level stretches of country such as make up the greater part of South Dakota. In mountainous regions, perhaps, this is not true. In those level stretches the number of rainfall stations should it seems to me, greatly exceed the number of temperature stations. Doubtless many temperature stations now in operation could be discontinued without loss, while an increase in the number of rainfall stations would enhance the value of the local record. The adoption of a policy along these lines would, doubtless, result in decreased expense of maintaining the entire service, since the cost of the equipment of a rainfall station is much less than that of a temperature station, while the replacement expense would be decidedly less.

I would be interested to learn how successful other section directors have been in getting observers to mail the booklets of Forms No. 1011 to the section center and how important they think it is that this should be done. Notwithstanding frequent requests to observers that they mail these booklets with Forms Nos. 1005 or 1009, I have seldom been able to have more than two-thirds of them sent in. In the interest of accuracy it seems to me that the data recorded in Form No. 1011 should be compared with the entries in Forms Nos. 1005 and 1009, and it is the practice of the Huron station to make this comparison. While the number of errors in copying that are detected is not great, it is great enough to make the comparison essential. The entire time required for this work at Huron does not exceed three hours a month for each of three persons.

Just as important as the accuracy of observations and of making a record of same is the accurate summarizing of the monthly reports, for the summarized values are those that come to the attention of the public. The practice in handling this work at the Huron station is as follows: First the data in Form No. 1011 are compared with the data entered in Forms Nos. 1005 and 1009. After this has been done the reports are checked for agreement between "Set Max." readings and maximum and minimum temperatures of the same day and of the following day, for precipitation entries or omissions that are obviously erroneous, and for agreement between precipitation entries and entries of snowfall and of notes that may appear on the form. This checking is done independently by two assistants or by one assistant and the official in charge. The maximum and minimum temperature, precipitation, and snowfall columns are then added on the adding machine from one copy of the report, and afterward the addition slips are compared with the other copy. When this has been done the means are computed by each of two persons. The reports are then summarized by one assistant and afterward carefully checked by the first assistant or the official in charge.

Delay in mailing reports in some instances by observers who, in other respects, are highly satisfactory is a source of annoyance. There are a few persistent offenders in this respect in South Dakota's corps of observers. When this is carried to the extent of practically nullifying the value of the station, there is, of course, nothing to be done but to change observers or to close the station. In South Dakota there are at least two of these offenders that are doing such excellent observational work that one hesitates to make a change, but continues to urge more prompt mailing of reports in the hope that they will finally acquire the habit of early mailing. I would be glad to learn in the discussion to follow what other section directors do in similar cases. Another heartbreaking experience is to have the services of an experienced, reliable, and faithful old observer terminated by death or for some other reason, after he has produced a recorded history covering many years and then to be unable to find a good observer to take his place. Such a station should not be permitted to die. Considerable expense to secure its continuance with the right kind of observer would be justified. The right man for the job might be found if the section director were to visit the station and make a careful survey of the possibilities.

How can correspondence best be handled so as to maintain cordial relations between section directors and cooperative observers. For the most part it is easy to write letters of instruction or letters calling attention to errors or to incorrect practices of observers in handling the work. It is only necessary for the section director to keep in mind the fact that observers are giving their services as such to the general public without financial compensation in order that he may be imbued with that feeling of appreciation that will, naturally, be given expression in the general tone of his letter. Indeed, an occasional letter of commendation is desirable and will be appreciated by observers. This should be a personal letter and not a circular letter, though there may be times when the latter would be effective. At all times correspondence should be characterized by the utmost courtesy and consideration. Not that observers resent criticism when criticism is justified and courteously offered. On the contrary, most of them will welcome criticism, rightly offered, that will lead to better results. Indeed, my experience has been that, in the rare instances where the services at a station have become decidedly

unsatisfactory, the observer will accept censure, when properly given without resentment and will try to improve his work. The temperaments and dispositions of observers should be carefully studied by the section director so that correspondence may be tempered to the individual and thus tie him more closely to the service in a friendly bond and build up the esprit de corps. Flattery is not needed, only frank friendliness and appreciation. It seems to me that the thing of greatest value in the inspection of cooperative stations is not to determine whether instruments are properly exposed and taken care of, for that can largely be done by correspondence, but rather the few hours of personal and intimate contact during which the section director and the observer can come to know each other and thus lay the foundation for continued friendly relations more firmly. Thus each may come to a better understanding of the problems of the other. Such understanding will lead to better results in the work and to greater satisfaction for both the section director and the observer in carrying it on.

In this paper I do not attempt to eulogize cooperative observers. I fear that I am unable to do justice to those unselfish individuals who, day after day and year after year, prompted by a desire to serve their fellow man, faithfully and conscientiously give their time and effort without financial compensation, and often, doubtless, at great inconvenience to themselves, to secure a reliable climatological history of their respective localities. I hope they feel that they have adequate reward in the consciousness of being good and faithful workers. The service performed by these men or women is not confined to taking and recording observations. They have many other calls upon their time in this connection. Many of them prepare weekly and monthly summaries of their data for the press. Occasionally one of them is called upon to take the records of his station into court. At all times, and particularly when unusual conditions prevail, he is subject to call from the people of his community for information as to temperature and precipitation. Also most of them prepare a weekly weather and crop report for the section center. This brings to me the thought that there is another group cooperating with the Weather Bureau that deserves commendation, namely, the weather and crop correspondents. A conscientious correspondent gives considerable time and thought to the preparation of his reports, and we have a few in South Dakota who make it their business to make long drives into the surrounding country to note crop conditions.

South Dakota has, perhaps, no observers who have served for such long periods as have a few observers in other sections, but she has many who have served long enough to be placed on a special honor roll. She has 18 observers who have served 20 or more years, 10 who have served more than 25 years, 9 who have served more than 30 years, 1 who has served 39 years, and one, Mr. D. G. Gallett, of Aberdeen, who has served 40 years. In making the above statement I have considered a family as one observer. Four of the above number fall into this class. Two sons, carrying on after the deaths of their fathers, and one widow after the death of her husband, have brought the total period of family service in each case to 33 years, and one son after the death of his father has brought the total period of family service to 39 years. These are records of which the makers of them can well be proud.

CONVENIENT METEOROLOGICAL RECORDS

By GEORGE B. WURTZ

[Weather Bureau office, Lexington, Ky.]

All business and professional activities require records, and in the light of experience these records should be in such form as readily to group themselves into classifications convenient for both comparison and summation.

Both in business and in our own professional work the time groups have logically arranged themselves into weekly and monthly periods. These two periods are not at present entirely commensurate; but, happily, it appears the time is not far distant when our international calendar conferences will make them so by adoption of the 4-week month, with 13 months to a calendar year.

In most of our work our records are arranged as nearly as practicable on the monthly basis and we customarily compute these in such time periods.

The last revision of our principal meteorological forms occurred about 28 years ago. At that time the committee handling the matter was somewhat divided on the size. The central office apparently adhered to the old size; the station representatives advocated one more conveniently slipped into the pocket, and especially convenient for use in court. With the present policy of taking the original records to court only when the certified compilations will not serve equally well, this necessity of convenience need not longer enter into the discussion. At that time, though compactness was urged, no change in size resulted, but the principal form, the present Form 1001, had added to it for station use Form 1014, to group daily data from a number of separate forms into a composite record on a single sheet for one day. For the study of several kinds of hourly data for a single period or not to exceed a single day, this is excellent; but for consideration of more extensive periods than a day, these records on Form 1014 are too extended and require more compact recompilation.

In all studies and compilations the monthly series on a single page is the more useful. The necessity for grouping arose not from the difficulty of consulting two or more data on separate pages but from the defective system of ruling the time lines on forms or having to obtain data from blurred press copies on flimsy tissues, often illegible and widely scattered in the files.

In making all forms of scale the mechanic's rule, the draughtsman's scale, the engineer's transit circles, diverse ruling is employed to avoid error. There is no reason why, in making our records, we should not employ the same efficient devices. In truth, in some forms we do; in others we do not.

It is a physiological fact that the eye comprehends readily no more than three things. It focuses on a single thing, as for instance, a line and takes in with less distinction the ones on either side, while the next in order farther away from the central point of focus begins to fade out into the borders of obscurity. When guide lines are marked in groups of five by inclosure with boundary lines of distinguishing size or color, the eye can place itself with fair accuracy amongst the seven, selecting any single one. Increase the number between the distinguishing guide lines to more than five and selection of any single line becomes chance.

In all rulings of date lines and time lines for hourly periods suitable subdivision rulings should be used in every instance. It has become universal in all accounting systems. It should be so, too, in ruling our record

forms. If this had been done in the first place, and the use of press copy books abandoned, there would have been little need for form revision in 1904, and the records would have occupied but one-fifth the space and the printing bill would have been less.

Still another inconvenience has persisted from former years; we still turn some pages one way and some another. And, furthermore, the pages are not bound side by side, as has been the standard custom for centuries, but many of the pages are joined end to end in a position much as in ancient times papyrus was unrolled. Even papyri were improved and paged or columned so that one section was next to another side by side for more ready consultation.

In the present form of our main record one has difficulty in selecting the time lines; he must use one page for a desk with its bottom jammed against the body, often soiling it, while he consults the page above, or, if consulting the lower page, he flops the upper into his ink well. And then, to give variety, when he consults a third, he must twist the whole volume about, scattering the trappings from his desk.

All of this is illogical and unnecessary. The records will be just as accurate and more handy and usable if all pages are arranged upright, bound side by side, and ruled with that consideration for the limitations of selection by distinguishing division lines at intervals. For date lines the marking interval might be based on either weekly intervals or in groups of five, and the vertical columns should be in groups of no more than 6, which would make 4 equal groups for the 24 hours. These latter rulings would then conform as well with the present rulings of automatic register forms.

While rulings are under discussion, we might as well consider the serial records of observations on pages 2, 3, 10, and 11 of Form 1001. For upwards of 60 years we have been entering the amount, kind, and direction of clouds all jumbled together; and to-day, when considering analysis of conditions above the earth, these records are practically useless unless recomputed. Just at the present we do record the predominant direction of the so-called upper and lower cloud levels, but we then ignore all the others.

Prevailing direction may be of some value, as indicating somewhat around the normal tendency, but so much of our scientific progress is made through study of the abnormal—the unusual—and searching for the related causes.

Except for the magnitude of its obscuration, quantity of cloud is of no great importance. What is of more importance is that cloud movement shows the trend of winds otherwise beyond our reach.

So it seems, since the various classifications of clouds indicate that many air layers, each should be recorded so as not to obscure the individuality of these layers. The present standard classification relates to about 9 levels and about 10 kinds of clouds if we separate cirrus from cirro-stratus clouds, which in nature probably are not so distinctly separated in movement. Nevertheless, for space taken in recording kind, direction, and for an unused blank there is found ample place to record separately each individual classification with its direction, as shown in a sample page of Form 1001 appended herewith.

Then, as well, we have need for the relative frequency from every direction. When each is in its separate column for classification and record of direction, it is then very easy to record the totals of the several directions, making summary of a complete record.

As to fog. Fog is perhaps of the same texture as stratus, and in an observation should not be ignored. On the other hand, it is believed no one ever heard of fog progressing against or across a wind. It always moves with it, and to record its direction is only to duplicate that made in another place by the wind vane. To count its surface direction amongst those of the lower clouds is only to vitiate the record we are making of winds above the earth. Its direction is of no importance.

Fog with haze and smoke, whether light or dense, may logically be recorded with state of weather at observation times; but from a consideration of its effect on both marine and aerial navigation, it should as well be recorded so as to show the period of continuance, and at no infrequent intervals the effect on visibility according to some standard scale. This would be a far more valuable record, both for current report and for future consideration from the summary of longer records. These effects on visibility are entirely worthy of a separate page for records of these elements. This record may well be developed from the experience of effects in our reporting for obstruction to navigation.

Permit me again to emphasize the necessity for arranging our record pages in logical position, with none upside down, crosswise or arranged in two-storied effect. Let's bind our books as the experience of the whole world has found most practicable since the inception of printing.

And, lastly, let us adhere to reasonable uniformity in our compilations. Let us not summarize, say, days of dense and light fogs one way in Form 1001, then another way in the means book. If it is necessary in one place to count as a day of light fog no day with dense, it should be uniform in both records. Neither should a day of snowfall as recorded in the summary of Form 1001 be one with 0.01 inch of melted snow and in the means book be one with 0.1 (one-tenth) inch unmelted, as makes the heading on page 29 of the latter. There may be other occasions of inconsistency that some of you recall. Let us eliminate them amongst ourselves before we betray these inconsistencies to the public, who are in increasing numbers consulting our compiled records.

TREE RINGS AND WHEAT YIELDS IN SOUTHERN SASKATCHEWAN

LYMAN B. POWELL

[45 Canada Life Building, Regina, Sask.]

This is the record of a study of radial tree growth at two points in southern Saskatchewan. The method followed is that set out by Dr. A. E. Douglass. A relationship is found between tree growth and wheat yields in southern Saskatchewan. Since crop records in this district go back only to 1898 and meteorological records go back only to 1883, the tree-ring chart, which goes back to 1763, is valuable in studying weather cycles which affect crop yields.

Most of southern Saskatchewan is a flat prairie with no trees. There are trees, however, in the eastern part and on Wood Mountain and the Cypress Hills in the west; but most of the old trees have been cut, and stumps rot so quickly that they can not be used for counting tree rings. There are also scattered clumps of trees near rivers and swamps. Trees from two such localities were studied. Eight cross sections of ash and one old elm were collected at the Trossachs grove 20 miles west of Weyburn in 1931.

Five samples of ash from Roche Percee, near the Souris River, were gathered the same year.

The time of felling of all the trees, except one at Trossachs and one at Roche Percee, was known. It was found by cross identification, however, that two of the trees whose date of felling was known had been dead for a year or two before being cut. The two trees whose dates of felling were not known were easily cross identified with the others, wide rings being found as valuable as narrow ones for this purpose.

Width of the rings was measured with an ordinary wooden ruler in centimeters by eye. The longest radius was used in each case for ease in measurement. The record from each tree was plotted separately on cross-section paper and cross identified with others in the group. The later years in some of the old trees showed small annual variations and were omitted, as they would have tended to smooth the curve. The average growth for each tree was then calculated. The percentage which each year's growth was of the average was then determined. These figures were averaged, making two graphs showing annual percentage variation of radial tree growth from the average, at Roche Percee and Torssachs.

A relationship between the two curves was found to to exist. One white spruce from Maple Creek was also found to have a relationship to the Trossachs curve. The Trossachs chart was then correlated with wheat yields per acre in crop district No. 2 (Regina-Weyburn) the coefficient being $+0.31 \pm 0.10$. Since the surrounding crop districts show relationship with crop district No. 2, this Trossachs curve shows to some extent crop conditions in southern Saskatchewan. Large discrepancies occurred in years when rust affected wheat, as in 1916, or where frost killed buds in trees, as in 1915, which was a bumper crop year, but a poor year for the trees. The Roche Percee curve showed no relationship to wheat yields in crop district No. 1, where Roche Percee is situated; however, Dr. O. C. Stine, of the United States Department of Agriculture, found that this curve shows a relationship to crop yields in North Dakota.

It was thought that since trees are perennial and wheat is an annual plant, there might be a lag in tree growth due to conservation of energy in the tree and soil moisture which the roots could reach. To determine the amount of this lag the Trossachs curve was correlated with the same series of figures for the previous year. r was $+0.58 \pm 0.03$. So the relationship is r or practically one-third. The chart was corrected by subtracting from each figure one-third of that of the year previous, and the revised curve correlated with wheat yields. The improved correlation, $r = +0.38 \pm 0.01$, justified the correction.

The charts were examined by several parties for cycles, but no small cycles were found to predominate. However, Dr. Dayton C. Miller, of Cleveland, Ohio, found evidence of a cycle of over 50 years, suggesting the 55-year weather cycle discovered by other investigators.

The conclusions from this study are as follows:

1. There had been enough moisture in southern Saskatchewan to grow trees for the last 150 years.
2. Extremely poor years have been the exception.
3. A relationship exists between tree growth at Trossachs and wheat yields per acre in southern Saskatchewan, improved by eliminating moist years which cause rust and cold years which are bad for tree growth.
4. A correlation exists between Roche Percee tree growth and wheat yields in North Dakota.
5. There is a relationship between tree growth at Roche Percee and Trossachs.
6. Roche Percee tree growth is not related to wheat yields in southern Saskatchewan; Trossachs tree growth is not related to wheat yields in North Dakota.
7. There is a carry-over of one-third of each year's tree growth to the next year due to the conservation of energy in the tree, or soil moisture, or both.
8. The only important cycle found was one of over 50 years.
9. Trossachs tree growth correlated with Qu'Appelle May–June rainfall (1884 to 1931) gave $r = +0.32 \pm 0.09$.
10. Lack of short cycles makes prediction of wheat yields from tree growth impossible.

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A REVIEW OF "THE STRUCTURE OF THE WIND OVER LEVEL COUNTRY"

[Meteorological Office Geophysical Memoirs No. 54, by the late M. A. Giblett and other members of the staff. Pp. 119, with 21 plates]

By G. GRIMMINGER

[Weather Bureau, Washington, D. C.]

This important memoir is divided into five distinct parts.

Part 1. Instrumentation and installation.—Dines pressure tube anemometers were mounted at the tops of four 50-foot towers, three of which were set at the corners of an equilateral triangle having sides of 700 feet, approximately the length of a rigid airship. About 3,500 feet away from this triangle there was a fifth tower 150 feet high at the top of which were mounted an anemometer and a recording electrical thermometer, thus making it possible to determine the vertical gradient of wind speed and of temperature at any time. The wind directions were recorded on Baxendall recorders. In order that the details of the fluctuations in speed and direction might be studied, open-time scales were used, the largest giving 1 inch of record in 42 seconds. An analysis is given of the instrumental errors in the speed and direction records.

Part 2. Horizontal fluctuations in wind in time and space.—The results of a statistical study of the records are discussed and some of the conclusions reached are as follows: During an adiabatic or superadiabatic gradient large, or major, eddies are present which vary in length (down wind) from 3,000 to 8,000 feet and in width (across wind) from 600 to 2,000 feet. These major eddies are characterized on the speed record by fluctuations of comparatively long period, each of which shows a sharp increase in speed followed by a gradual decrease. Imbedded in the major eddies are a large number of smaller eddies which are recognized on the speed record by numerous short period fluctuations superimposed on the fluctuations of long period. On the other hand, when a surface inversion is present there are no pronounced major eddies, the gusts being due mainly to the small scale eddies, which may also disappear if the inversion becomes strong enough. Some interesting records are included which show the sudden changes occurring in wind speed and direction during the passage of fronts and thunderstorms.

Part 3. A theory of eddies.—In this part C. S. Durst puts forward a theory to explain the two main types of

eddies mentioned in part 2. The short period eddies are thought to be due to the reaction between the air stream and surface obstacles and to the friction between the air and the ground. The major eddies, however, are believed to be thermal in their origin and due to convection currents set up in the atmosphere, since they occur only when the lapse rate is favorable for convection. From laboratory experiments on convection in liquids Durst concludes that when the convectional eddies are present the lower portion of the atmosphere takes on a cellular structure, and that each cell contains a convectional eddy which is identical with the major eddy mentioned above. The cells travel with the mean velocity of the wind, while the motion of the air within a cell relative to the mean wind is supposed to be as follows: Relatively cool air moving with the velocity of the upper layers descends in the forward part of the cell; upon contact with the ground, its forward motion is checked and it moves toward the rear of the cell becoming heated and filled with frictional eddies. This air is relatively warm when it nears the rear of the cell and therefore rises to the cell top where it moves forward toward the front of the cell; it then descends again, and the cycle is repeated. The horizontal dimensions of the cells would be the same as those given for the major eddies in part 2, and their heights 1,500 feet or more. This novel theory postulating the existence of atmospheric cells, each containing a convectional eddy, explains a number of the facts revealed by the anemograms, and merits further investigation.

Part 4. The variation of wind with height.—As a result of a study of the records made by instruments at the heights of 30, 40, 50, and 150 feet, it is found that the vertical gradient of wind speed is usually less for light winds than for strong and less by day than by night; and also that the vertical gradient of wind speed depends on the vertical temperature gradient.

Part 5. Application of the results of the investigation to the hydrodynamical theory of turbulence.—Data are given here showing that a strong surface inversion has the effect of reducing the coefficient of turbulence. From the consideration of the equations of motion of a turbulent fluid, it is concluded that when the convectional eddies are present, the simplified form of these equations, in which the coefficient of viscosity is replaced by the coefficient of eddy viscosity, is rigorously applicable only for heights above 1,500 feet.

This investigation appears to be the first of its kind in which simultaneous records have been made not only of wind speed but also of wind direction and of temperature. The concept of the convectional eddy and its theory are entirely new. The memoir represents a searching investigation into wind structure and merits the attention of all who are interested in this branch of meteorology.

It may not be out of place to mention here that a research on wind gustiness was begun several years ago at the University of Michigan by R. H. Sherlock and M. B. Stout and is still in progress. It is anticipated that the final results of this investigation will contribute further to our knowledge of wind structure.

THE TROPICAL STORM OF OCTOBER 30–NOVEMBER 13, 1932

By C. L. MITCHELL

[Weather Bureau, Washington, Dec., 1932]

This storm was remarkable not only for its great intensity so late in the hurricane season, but also because of its unusual path during its early history and its moving into the Caribbean Sea at least two weeks later than any other tropical disturbance of hurricane intensity during the last 50 or more years.

The first evidence of this cyclonic circulation was noted on October 30 about 200 miles east of the island of Guadeloupe, West Indies. The disturbance, which was yet of slight intensity, passed over or near Guadeloupe during the 31st. During the next two days its direction of movement was unexpected, and, for this low latitude, unprecedented. Instead of passing westward a short distance south of Puerto Rico, it moved almost directly southwestward, apparently reaching hurricane intensity on November 2, and it was central approximately 75 miles north of Willemstad, Curacao, Dutch West Indies, the morning of that date. The next day its center passed westward about 50 miles north of Punta Gallinas, Colombia, the northernmost point of South America. For three days—November 2 to November 5, inclusive—the disturbance moved very slowly westward with steadily increasing intensity, the steamship *San Simeon* in lat. 14° 30′ N., long. 79° W., reporting a barometer reading of 28.48 inches and a southeast wind of force 12 at 7 a. m. of the 6th, just as the disturbance started to recurve to the north. During the night of the 8th–9th the storm recurved to the northeast and began to move more rapidly, the center passing near Cayman Brac on the early morning of the 9th. Later in the forenoon it passed inland over Cuba near Santa Cruz del Sur and between 1 p. m. and 2 p. m. it passed to sea again near Nuevitas, where a barometer reading of 28.85 inches and an estimated wind velocity of 125 miles per hour were reported. Charts VIII, IX, and X illustrate this storm on the 7th, 9th, and 11th, and show its track up to the latter date.

During the next several days the storm moved almost directly northeastward, and finally merged on the 13th with an extensive disturbance that passed eastward over the Canadian maritime Provinces and Newfoundland during the 12th–13th. At 8 a. m. of the 12th, St. Georges, Bermuda, reported a pressure of 29.38 inches, but it undoubtedly was lower later in the forenoon, when a maximum wind velocity of 88 miles per hour from the north was registered at that place.

The reports of damage caused by this very severe tropical storm are quite incomplete. Press dispatches indicate that some damage resulted along the northern coasts of Venezuela and Colombia and on Providence Island and Cayman Brac in the western Caribbean Sea. On Providence Island 36 houses were reported destroyed and crops ruined, while on Cayman Brac 69 persons were reported killed, hundreds were injured, and the island almost completely devastated.

The storm damage at Santa Cruz del Sur, Cuba, reached the proportions of a major catastrophe. According to the Associated Press the number of deaths reached 2,500 and less than 10 per cent of the town's 4,000 inhabitants escaped unhurt. The survivors stated that the hurricane began about 3 a. m. of the 9th, later driving the sea into the town and "converting it into a great lake," with scarcely a house left standing. Damages are estimated tentatively at several millions of dollars.

The damage on the island of Jamaica was comparatively small, except that there was over a 50 per cent loss to banana trees in some localities.

Advisory warnings were issued twice daily for a period of two weeks, beginning on October 31.

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C. FITZHUGH TALMAN, in Charge of Library

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING NOVEMBER, 1932

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures the reader is referred to the January, 1932, REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged well above normal values at Washington and Madison and slightly below at Lincoln.

Table 2 shows an excess in the total solar radiation received on a horizontal surface at Washington, Lincoln, Chicago, New York, Fresno, and Pittsburgh and a deficiency at all other stations for which normals have been computed.

Table 3 shows low turbidity values for the month as a whole, while the values of November 10 are the lowest recorded in Washington since observations began in February, 1932.

Polarization measurements made at Washington on six days give a mean of 58 per cent with a maximum of 66 per cent on the 10th. At Madison one observation of 67 per cent on the 26th is the only value that may be accepted, due to misadjustment of the polarimeter during the fore part of the month. The Washington values are about normal for November, while the single reading for Madison is about normal for the mean but below the average November maximum.

TABLE 1.—*Solar radiation intensities during November, 1932*

[Gram-calories per minute per square centimeter of normal surface]

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Washington, D. C.											
Nov. 3	4.95	0.79	0.92	1.07							4.17
Nov. 10	4.95	.92	1.07	1.19	1.27	1.37	1.36	1.24	1.08	0.91	4.37
Nov. 14	3.45							1.12	.98	.76	3.81
Nov. 15	4.57	.76	.92	1.04							4.75
Nov. 22	2.74	.64	.77	.97							2.74
Nov. 23	3.45	.42	.74	.97	1.32						3.45
Nov. 28	1.60		1.00	1.17	1.40			1.05	1.02	.88	1.52
Nov. 29	2.06	1.02	1.16	1.33							1.52
Means		.76	.94	1.11	1.20	(1.37)	(1.36)	1.14	1.03	.85	
Departures		±.00	+.08	+.11	+.02		+.19	+.15	+.19	+.11	
Madison, Wis.											
Nov. 2	4.17	0.77	0.88								4.17
Nov. 3	4.17			1.05							4.57
Nov. 5	4.57	.78	.96	1.17	1.35						4.17
Nov. 16	1.78		1.13	1.28	1.45			1.25			2.36
Nov. 19	1.32				1.34						1.32
Nov. 21	1.60		1.12	1.27	1.40			1.19			1.45
Nov. 26	1.68	1.10	1.21	1.35	1.50						1.45
Means		.88	1.06	1.24	1.41			1.22			
Departures		±.00	+.05	+.09	+.11			+.08			
Lincoln, Nebr.											
Nov. 2	4.75				1.27		1.46	1.15	1.07		5.16
Nov. 4	7.04							1.10			6.76
Nov. 12	2.36	0.90	1.04	1.23	1.44		1.33				3.45
Nov. 23	3.00						1.34	1.13	.98		3.81
Nov. 30	3.15		.92	1.17							3.99
Means		(.90)	(.98)	(1.20)	(1.36)		1.38	1.13	(1.02)		
Departures		±.00	−.04	+.03	+.02		+.03	−.05	−.02		

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans
	Gram calories per square centimeter												
1932	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*	*Cal.*
Oct. 29	309	125	251	121	236	353	167	46	209	244	149	319	240
Nov. 5	142	103	185	88	90	329	141	39	184	202	148	304	272
Nov. 12	237	137	206	98	190	307	114	38	172	266	----------	338	234
Nov. 19	204	144	228	147	155	260	120	18	200	202	193	314	221
Nov. 26	244	153	206	130	204	202	118	12	138	188	168	294	265
	Departures from weekly normals												
Oct. 29	+72	−60	+12	−17	+60	+35	+6	----------	−61	−40	−149	−49	----------
Nov. 5	−80	−63	−55	−30	−60	+42	−7	----------	−38	−13	−99	−115	----------
Nov. 12	+50	+1	−6	−5	+62	+48	−10	----------	−13	−53	----------	−124	----------
Nov. 19	+24	+15	+23	+50	+39	+24	+2	----------	+30	−120	−47	−120	----------
Nov. 26	+84	+26	+11	+44	+100	−3	+15	----------	−19	−117	−42	−82	----------
	Accumulated departures on Dec. 2												
	+9,688	+394	+1,524	+17,479	+20,771	+10,378	+6,412	----------	−9,403	−4,429	----------	−6,799	----------

TABLE 3.—*Solar radiation measurements, and determinations of atmospheric turbidity factor, β, Washington, D. C., November, 1932*

Date and solar hour angle	Solar altitude, h.	Air mass, m.	I_m	I_y	I_r	β	Blueness of sky	Atmospheric dust particles per cubic centimeter	Notes: (skylight polarization, P.) clouds, etc.
Nov. 3			*gr. cal.*	*gr. cal.*	*gr. cal.*				
3:49 a	14-00	4.08	0.906	*0.702*	0.581	0.060		727	
3:45 a	14-39	3.92	.932	.705	*.588*	.060			
3:41 a	15-17	3.77	.947	*.728*	.607	.065			
3:36 a	16-06	3.57	.970	.733	*.612*	.065			
3:10 a	20-11	2.88	1.028	.808	*.657*	.080			
3:04 a	20-59	2.77	1.019	*.715*	.662	.105			
1:47 a	30-26	1.97	.990	.754	*.629*	.160	4		P=54.5
1:43 a	30-48	1.95	.990	*.754*	.629	.160			
Nov. 10									
3:07 a	18-58	3.05	1.200	.876	*.690*	.030		321	
3:03 a	19-23	2.99	1.203	*.875*	.693	.030			
2:11 a	26-01	2.28	1.346	.942	*.748*	.040			
2:08 a	26-23	2.25	1.359	*.946*	.751	.040			
1:27 a	30-10	1.98	1.352	*.970*	.766	.045	6		P=66.0.
1:23 a	30-38	1.96	1.339	.973	*.769*	.055			
0:02 a	33-51	1.79	1.391	*.973*	.754	.035			
0:01 p	33-52	1.79	1.385	.948	*.755*	.040			
1:43 a	28-54	2.06	1.335	.832	*.725*	.030			
1:46 p	28-38	2.08	1.334	*.831*	.721	.030			
2:57 p	20-16	2.87	1.241	.826	*.671*	.030			
3:00 p	19-50	2.93	1.236	*.825*	.673	.030			
3:26 p	16-03	3.59	1.113	.827	*.650*	.030			
3:32 p	15-07	3.78	1.080	*.822*	.643	.020			
3:36 p	14-30	3.94	1.089	.791	*.635*	.020			
3:40 p	13-52	4.10	1.054	*.788*	.637	.020			
Nov. 14									
2:34 p	22-23	2.60	1.153	.799	*.647*	.040		930	
2:37 p	22-00	2.65	1.167	*.797*	.643	.040			
2:46 p	20-50	2.81	1.140	*.773*	.639	.040			
2:50 p	20-18	2.88	1.105	.776	*.635*	.040			
3:21 p	16-05	3.57	1.028	*.728*	.613	.040			
3:24 p	15-29	3.70	1.030	.724	*.611*	.040			
Nov. 15									
3:22 a	15-32	3.70	.934	*.761*	.620	.060		701	
3:16 a	16-33	3.49	.991	.763	*.627*	.045			
2:49 a	20-19	2.87	1.149	.839	*.702*	.035			
2:42 a	21-10	2.75	1.156	*.846*	.705	.040			
2:09 a	25-10	2.34	1.216	*.902*	.721	.040			
2:05 a	25-36	2.32	1.226	.903	*.727*	.040			
0:06 a	32-32	1.86	1.290	.964	*.767*	.050	4		P=55.8.
0:00 noon	32-32	1.86	1.298	*.967*	.766	.045			
Nov. 22									
3:24 a	14-03	4.08	.769	*.630*	.516	.075		926	
3:20 a	14-08	4.02	.769	.632	*.521*	.075			
2:49 a	18-54	3.06	.960	.717	*.612*	.065			
2:41 a	19-55	2.92	.924	*.725*	.614	.080			
2:29 a	21-21	2.74	1.061	*.776*	.638	.050			
2:23 a	22-06	2.64	1.111	.781	*.636*	.035			

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Perkins, and Mount Wilson Observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic Diff. long.	Heliographic Longitude	Heliographic Latitude	Area Spot	Area Group	Total area for each day
1932	h. m.	°	°	°			
Nov. 1 (Naval Observatory)	11 49	−16.0	134.3	−10.0	------	25	25
Nov. 2 (Naval Observatory)	11 36	−1.0	136.2	−10.0	------	25	25
Nov. 3 (Naval Observatory)	11 48	+13.0	136.9	−10.0	------	25	25
Nov. 4 (Naval Observatory)	11 4	+28.0	139.1	−9.0	------	37	37
Nov. 5 (Perkins Observatory)	12 30	No spots			------	------	------
Nov. 6 (Perkins Observatory)	13 50	No spots			------	------	------
Nov. 7 (Mount Wilson)	12 0	No spots			------	------	------
Nov. 8 (Perkins Observatory)	10 20	No spots			------	------	------
Nov. 9 (Mount Wilson)	12 30	No spots			------	------	------
Nov. 10 (Naval Observatory)	11 39	No spots			------	------	------
Nov. 11 (Naval Observatory)	10 52	No spots			------	------	------
Nov. 12 (Naval Observatory)	12 27	No spots			------	------	------
Nov. 13 (Naval Observatory)	10 41	−8.0	344.7	.0	------	15	15
Nov. 14 (Naval Observatory)	10 24	+7.0	346.6	.0	------	9	9
Nov. 15 (Naval Observatory)	11 8	No spots			------	------	------
Nov. 16 (Naval Observatory)	11 42	No spots			------	------	------
Nov. 17 (Naval Observatory)	11 2	+15.0	314.8	+9.0	------	81	81
Nov. 18 (Mount Wilson)	12 35	+30.0	315.8	+9.0	------	306	306
Nov. 19 (Mount Wilson)	14 30	+45.0	316.5	+9.0	------	418	418
Nov. 20 (Naval Observatory)	11 32	+59.0	318.9	+8.0	------	833	833
Nov. 21 (Naval Observatory)	11 48	+72.0	318.6	+8.0	------	864	864
Nov. 22 (Naval Observatory)	10 17	+85.0	319.3	+8.0	------	926	926
Nov. 23 (Naval Observatory)	10 21	No spots			------	------	------
Nov. 24 (Naval Observatory)	11 8	No spots			------	------	------
Nov. 25 (Naval Observatory)	11 24	No spots			------	------	------
Nov. 26 (Naval Observatory)	11 59	No spots			------	------	------
Nov. 27 (Naval Observatory)	11 15	No spots			------	------	------
Nov. 28 (Naval Observatory)	10 48	No spots			------	------	------
Nov. 29 (Naval Observatory)	13 18	−73.0	67.3	+6.0	------	123	123
Nov. 30 (Naval Observatory)	10 23	−61.0	67.8	+5.0	------	185	185
Mean daily area for November							129

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR NOVEMBER, 1932

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, University of Zurich, Switzerland]

November, 1932	Relative numbers	November, 1932	Relative numbers	November, 1932	Relative numbers
1	7	11	9	21	25
2	10	12	9	22	----------
3	13	13	9	23	0
4	12	14	10	24	----------
5	0	15	10	25	----------
6	0	16	0	26	0
7	0	17	*Mc*14	27	0
8	0	18	24	28	*d*
9	0	19	27	29	8
10	7	20	31	30	12

Mean: 26 days=9.1.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, W. R. Gregg, in charge]

By L. T. SAMUELS

Free-air temperatures during November were practically normal in the lower levels and above normal in the upper levels at the midwestern and western stations, and mostly below normal at the eastern and southern stations. (Table 1.) The mean temperature for the month at San Diego is of special interest in that a marked inversion occurred from the surface to 1,000 meters, whereas the normal lapse rate for November at this station is positive. In this connection it is noted that a greater northerly wind component than usual obtained at the surface at this station during the month, which probably was a factor in causing the temperature to be below normal; also, the usual prevailing northeast wind at 500 and 1,000 meters was replaced by an east and east-southeast wind, respectively, which likewise probably was a factor in causing the mean temperatures at those levels to be above normal.

Free-air relative humidities averaged mostly above normal except at Omaha and Washington, where negative departures occurred.

Resultant wind directions in the lower levels were close to normal except in the southeastern section of the country, where a pronounced northerly component prevailed as compared to the normal westerly. (Table 2.) Resultant velocities at these levels were below normal at most stations.

At the higher levels resultant directions were close to normal with resultant velocities considerably below normal at most stations, except in the northwestern States where velocities were generally in excess of normal.

Five airplane observations were made during November at Fairbanks, Alaska, as part of the International Polar Year program. In connection with the latter a total of 91 sounding-balloons were released at Dallas, Ellendale, and Omaha between August and December, 1932, inclusive. From 57 (63 per cent) of these balloons the instruments already (December 29, 1932) have been returned.

TABLE 1.—*Free-air temperatures and relative humidities during November, 1932*

TEMPERATURE (° C.)

Altitude (meters) m. s. l.	Atlanta, Ga. (303 meters) [1]		Boston, Mass. (4 meters) [2]		Chicago, Ill. (187 meters) [3]		Cleveland, Ohio (246 meters) [3]		Dallas, Tex. (146 meters) [4]		Ellendale, N. Dak. (444 meters)		Omaha, Nebr. (300 meters) [5]		Pensacola, Fla. (2 meters) [6]		San Diego, Calif. (9 meters) [6]		Washington, D. C. (2 meters) [6]	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	6.3	(7)	4.0	------	−0.3	(7)	1.8	(7)	5.5	(7)	−2.4	−0.1	−1.8	(7)	11.4	−2.2	15.3	−2.6	1.3	−4.3
500	6.7	(7)	2.5	------	0	(7)	2.0	(7)	9.3	(7)	−2.5	−.2	−.4	(7)	11.7	−1.6	17.9	+1.0	2.5	−3.0
1,000	6.9	−1.5	1.7	------	−.2	−1.6	.3	−1.1	9.3	−.5	−1.0	+.9	2.2	−.8	11.1	−.9	18.5	+2.2	2.5	−1.8
1,500	6.5	−.2	1.0	------	−.5	−.6	−1.4	−1.5	8.3	0	−.7	+1.5	2.3	+.1	------	------	------	------	------	------
2,000	5.3	+.3	.3	------	−1.3	+.4	−2.2	−.5	6.4	−.1	−2.1	+1.7	1.2	+.8	8.5	−.9	14.7	+3.2	1.1	−.2
2,500	3.7	+.5	−1.6	------	−3.0	+.6	−3.9	−.3	4.4	0	−4.7	+1.3	−.5	+1.4	------	------	------	------	------	------
3,000	1.1	0	−3.9	------	−5.4	+.5	−5.7	+.2	2.6	+.6	−7.7	+.9	−2.6	+1.9	3.8	−1.5	10.1	+3.9	−1.4	+.3
4,000	−4.9	−.5	−8.7	------	−10.7	+.1	−10.7	+.1	−2.5	+.8	−14.2	+.1	−8.8	+1.2	−2.0	−1.5	4.2	+3.9	------	------
5,000	−12.2	−2.0	−15.1	------	−16.6	+.2	−18.2	−1.4	−8.4	+.8	------	------	−15.3	+.3	------	------	−3.0	+3.9	------	------

RELATIVE HUMIDITY (PER CENT)

Surface	84	(7)	69	------	80	(7)	78	(7)	74	(7)	75	−3	76	(7)	84	+2	75	+17	77	+3
500	82	(7)	65	------	75	(7)	75	(7)	62	(7)	74	−2	68	(7)	79	+4	59	+9	65	0
1,000	74	+12	64	------	67	−1	72	+4	53	−6	65	0	55	−3	72	+4	46	+7	57	−3
1,500	66	+8	59	------	61	+2	66	+7	49	−3	59	+1	47	−6	------	------	------	------	------	------
2,000	60	+7	53	------	56	+3	57	+4	45	−2	61	+6	45	−5	59	+4	34	+5	44	−9
2,500	53	+8	51	------	52	+3	56	+7	43	+1	63	+9	44	−5	------	------	------	------	------	------
3,000	52	+11	50	------	50	+2	55	+7	40	+2	65	+11	42	−8	52	+8	29	+4	32	−6
4,000	45	+10	47	------	47	+3	52	+8	37	+3	48	−8	44	−7	52	+8	26	+4	------	------
5,000	45	+22	45	------	47	+1	54	+8	36	+4	------	------	44	−3	------	------	25	+4	------	------

[1] Temperature and humidity departures based on normals of Due West, S. C.
[2] Observations made by Massachusetts Institute of Technology.
[3] Temperature and humidity departures based on normals of Royal Center, Ind.
[4] Temperature departures based on normals determined by interpolating between those of Groesbeck, Tex., and Broken Arrow, Okla. Humidity departures based on normals of Groesbeck, Tex.
[5] Temperature and humidity departures based on normals of Drexel, Nebr.
[6] Naval air stations.
[7] Surface and 500-meter departures omitted because of difference in time between airplane observations and those of kites upon which the normals are based.

Weather Bureau airplane observations made near 5 a. m.; Navy airplane observations near 7 a. m.; Ellendale kite observations near 9 a. m. (seventy-fifth meridian time).

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during November, 1932*

[Wind from N=360°; E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,528 meters)		Atlanta, Ga. (309 meters)		Bismarck, N. Dak. (518 meters)		Brownsville, Tex. (12 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (192 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	23	1.1	22	1.5	293	1.0	332	1.5	185	2.1	277	4.8	284	0.9	206	1.9	216	0.5	244	2.0	350	2.4	30	2.8
500			39	2.6			65	1.8	222	3.3			230	4.3	217	4.2	213	2.7			21	5.0	44	5.9
1,000			32	2.0	280	6.6	144	.7	265	4.7			244	4.8	244	5.3	269	3.5	252	6.5	335	2.4	51	2.7
1,500			301	2.7	281	8.3	314	1.4	277	8.3			254	5.9	250	6.1	292	4.0	270	10.1	299	4.0	71	1.3
2,000	321	2.0	306	6.8	282	9.3	336	4.4	284	10.2	280	7.9	273	5.4	252	6.5	303	5.1	281	11.2	312	5.1	315	1.6
2,500	301	4.1	310	9.6	288	9.7	310	4.1	296	10.3	289	14.9	276	6.5	258	7.7	304	5.1	280	13.0	302	6.7	297	1.1
3,000	302	6.6	333	7.3	276	12.2	302	4.8	288	11.2	298	12.6	284	6.8	267	9.5	303	5.7	286	13.9	272	9.0	349	.3
4,000	301	9.8	318	8.6			307	4.0	322	8.1	304	12.7					293	7.6					295	2.6
5,000	297	9.2					315	4.8			281	6.5					310	6.0					276	6.2

Altitude (meters) m. s. l.	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (83 meters)		New Orleans, La. (25 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (402 meters)		Omaha, Nebr. (306 meters)		Phoenix, Ariz. (356 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D. C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	35	0.4	170	0.5	56	0.6	44	1.6	126	1.2	351	0.5	190	8.5	101	1.7	146	2.4	134	0.7	158	1.9	323	2.5
500	30	.4	153	1.1	250	1.2	61	3.2	51	1.6	208	1.0	222	3.7	88	3.2			236	3.1	190	8.3	321	4.7
1,000	50	1.3	156	3.5	255	3.4	25	2.3	47	1.3	267	3.4	258	5.6	77	3.0			253	5.7	206	10.1	327	3.8
1,500	24	.8	200	5.8	287	5.1	340	2.2	296	.4	298	3.5	265	6.7	74	1.9	171	3.3	261	7.0	217	9.6	296	3.6
2,000	282	1.2	222	8.0	303	6.2	345	4.0	276	.6	300	4.2	272	7.5	27	.8	210	3.6	248	8.3	213	9.4	284	4.6
2,500	283	2.1	242	10.6	306	9.2	342	5.0	244	2.5	307	5.8	276	8.0	288	1.9	259	3.9			219	11.0	290	5.4
3,000	296	3.3	260	12.1	306	9.9	313	3.2	307	2.1	309	6.6	288	9.2	296	2.9	276	6.4					275	5.5
4,000	260	3.3	290	12.4							285	7.6	293	14.0	299	6.4	285	8.8						
5,000													302	13.7	300	8.2								

RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, Montrose W. Hayes in charge]

In November, 1932, floods occurred only in the Atlantic slope and east Gulf of Mexico States. None of them was important. The loss amounting to $3,200, was confined to matured crops in Alabama and was caused by the Tombigbee River.

The following tables show the river-gage stations at which flood stage was reached and the value of property saved through flood warnings:

Table of flood stages in November, 1932

[All dates are in November unless otherwise indicated]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Farmington: Collinsville, Conn	5	19	19	6.6	19
Connecticut: Hartford, Conn	16	20	22	18.0	21
Susquehanna: Oneonta, N. Y	12	20	20	13.2	20
Roanoke: Williamston, N. C	9	7	17	10.5	15–16
Peedee: Mars Bluff Bridge, S. C	17	5	10	17.8	7
Saluda:					
Pelzer, S. C	6	Oct. 31	2	9.2	1
Chappells, S. C	12	2	4	15.3	3
Broad: Blairs, S. C	14	1	2	17.3	2
Santee:					
Rimi, S. C	12	3	17	15.5	7
		22	24	12.2	24
		27	30	13.5	30
Ferguson, S. C	12	2	30	13.6	8
Jamestown, S. C	12	1	19	13.5	15–16
		3	8	18.8	5
Savannah: Ellenton, S. C	14	23	24	15.2	23
		28	30	15.8	28

Table of flood stages in November, 1932—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
EAST GULF OF MEXICO DRAINAGE	*Feet*			*Feet*	
Choctawhatchee: Caryville, Fla	10	3	6	11.1	4
Black Warrior: Tuscaloosa, Ala	46	27	27	48.0	27
Tombigbee:					
Demopolis, Ala	39	Oct. 17	5	56.6	Oct. 26
		29	Dec. 3	41.8	Dec. 1
Lock No. 3, Ala	33	Oct. 17	10	56.8	Oct. 27–28
		27	(1)	43.6	Dec. 2
Lock No. 2, Ala	46	Oct. 18	6	57.5	Oct. 29
Lock No. 1, Ala	31	Oct. 18	11	38.6	1–2
Pearl: Jackson, Miss	18	11	15	19.1	14

[1] Continued into December.

VALUE OF PROPERTY SAVED BY WARNINGS

ATLANTIC SLOPE DRAINAGE

Connecticut River in Connecticut	$40,000
Saluda River in South Carolina	500
Broad River in South Carolina	700
Congaree River in South Carolina	3,000
Catawba-Wateree River in South Carolina	7,500
Santee River in South Carolina	4,000

EAST GULF OF MEXICO DRAINAGE

Tombigbee River in Alabama	20,000

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[By the Marine Division, Willis E. Hurd temporarily in charge]

NORTH ATLANTIC OCEAN, NOVEMBER, 1932

By WILLIS E. HURD

Atmospheric pressure.—As indicated by Table 1, the average pressures at the middle latitude centers of anticyclonic action, as shown by Bermuda and Horta, were about normal for November, 1932. The monthly range in pressure, however, exceeded 1 inch at these stations. Along the American coast from Nantucket to Belle Isle the average barometer was from 0.1 to 0.2 inch above the normal, and the European coast from Portugal to the Shetland Islands also gave abnormally high average pressures. At Lerwick the November range exceeded 2 inches.

The Iceland LOW, as indicated by Reykjavik, was a tenth of an inch below normal, and the November pressure extremes at this Iceland station were 30.50 inches on the 15th and 28.39 inches on the 22d.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, November, 1932*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.82	-------	30.28	15, 28	29.37	4
Reykjavik, Iceland	29.50	−0.12	30.50	15	28.39	22
Lerwick, Shetland Islands	29.82	+.12	30.75	13	28.63	23
Valencia, Ireland	30.03	+.14	30.49	28	29.66	22
Lisbon, Portugal	30.12	+.08	30.42	26	29.69	16
Madeira	30.04	+.03	30.34	26, 27	29.57	15
Horta, Azores	30.13	.00	30.61	28	29.25	16
Belle Isle, Newfoundland	30.05	+.17	30.46	17	29.32	6
Halifax, Nova Scotia	30.15	+.20	30.78	28	29.54	1, 30
Nantucket	30.15	+.10	30.74	4	29.55	19
Hatteras	30.13	+.02	30.61	4	29.60	9
Bermuda	30.06	−.02	30.42	5	29.30	12
Turks Island	29.93	−.06	30.00	20, 21, 25, 26	29.74	10
Key West	30.01	−.01	30.23	14	29.70	9
New Orleans	30.16	+.06	30.52	28	29.83	10
Cape Gracias, Nicaragua	29.86	−.04	29.98	21	29.48	7

NOTE.—All data based on a. m. observations only with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—In northern waters storms, as a rule, ran in higher latitudes than normal for November, as was similarly true in October. Along the northern shipping routes the number of November gales with forces exceeding 8 showed very little if any increase over those of the preceding month, and the weather as a whole may be considered as less stormy than usual so far as it was affected by purely extratropical conditions. In American coastal waters north of the thirtieth parallel the number of gales was somewhat higher than the average for the month, and of these the greater part were due to a storm which first appeared as a shallow depression in the upper Gulf of Mexico on November 24. On the 26th this disturbance entered the Atlantic from South Carolina, attended by gales over the neighboring part of the sea. On the 27th and 28th it was causing fresh to whole gales over a considerable region north and west of Bermuda. On the 29th, central near 35° N., 65° W., it had acquired locally a force of 11, and on the 30th, south of Nova Scotia, similarly high wind forces occurred in its southern quadrants. (See Chart XI.)

Of other storms, specific mention may be made of one which caused gales of force 8 to 11 over a wide field west of the British Isles on the 9th to 11th, and with which one of the tropical cyclones of the month was merged.

Another was a cyclone which, originating on the 22d south of Newfoundland, moved northeastward with increasing intensity, and on the 26th and 27th caused strong gales in British waters.

Tropical hurricanes.—The principal November cyclones of the North Atlantic were of tropical origin, and as their courses ran well into middle latitudes, trans-Atlantic shipping was much more seriously affected by them than by all the storms of extratropical origin.

The disastrous hurricane of the month was that which appeared as a depression east of the Antilles on October 30. In its course nearly across the Caribbean Sea until November 7, its northward swing across central Cuba on the 9th, and its passing of Bermuda on the 12th, it was for the most part a deep and intense cyclone. South of Nova Scotia, after combining partly with the lower extension of a cyclone centered far to the northward, it inclined more to easterly, passed the Azores on the 16th, with low barometer of 29.25 inches at Horta, and on the 19th lay as a depression over Spain.

The principal history of this hurricane, including its disastrous effect upon Cuba, is treated on p. 222 in this REVIEW. Allusion should be made, however, to the experience of the British motorship *Forresbank*, southbound in the Caribbean. She hove to in the teeth of the gale on the morning of the 6th, in 17° N., 81° 11′ W. "This," said the observer, Mr. Cameron, "was the last known position till Wednesday the 9th—17° 22′ N., 79° 25′ W." The lowest barometer reading on this ship was 27.96 inches (uncorrected), at 3 a. m. of the 8th. Vessels close to San Salvador Island on the 10th reported readings close down to 28 inches. Mr. Hagens, observer on the Dutch steamer *Binnendyk*, said that when in the most violent part of the storm on the 10th, "between 8 and 12 a. m. the barometer dropped about 20 millimeters, the largest drop on one watch in this writer's experience."

A pronounced effect of this hurricane was felt in the Canal Zone on November 6. The total wind movement at Balboa Heights, midnight to midnight of that date, was 543 miles, which is a record total for the month for the period 1908–1932. At Cristobal on the 7th the barometer fell to 29.64 inches, which is within 0.01 inch of the record low in 25 years. Ships from the hurricane belt were later reported arriving here in a battered condition.

While this storm was in progress, a second hurricane sprang up in lower middle Atlantic. It was first observed, with moderate gales, on the 3d, central near 15° N., 48° W. By a devious route it cut its way northward against a bank of high pressure, gathering energy. Late on the 7th the American steamer *West Campgaw* reported a northeast gale, force 11, barometer 28.73, near 29° N., 48° W. By the 10th the cyclone had advanced on a northeasterly course to the Azores, attended by hurricane winds in southern quadrants. On the 11th, to the northward, it coalesced with a disturbance of higher latitudes.

Charts VIII, IX, and X, for November 7, 9, and 11, show both of these hurricanes in important stages of their existence. Chart X also shows a development of the extensive northeastern cyclone with which the mid-longitude hurricane of the 3d–10th had just merged.

Fog.—Much less than the normal amount of fog for November occurred this month, and none was reported to the eastward of the meridian of 35° W. In Newfoundland waters and on the Grand Banks it was reported altogether on 4 days, south of Nova Scotia on 7 days, and along the coast of the United States between 35° and 45° N. on 1 to 2 days.

Waterspout damage.—An Exchange Telegraph dispatch from Valencia, Spain, dated November 11, said that 10 Spanish fishermen were believed to have perished when their smack was capsized by a waterspout. Three of the bodies were recovered.

OCEAN GALES AND STORMS, NOVEMBER, 1932

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Themisto, Du. S. S.	Durban	Montreal	49 28 N	64 50 W	Nov. 1	6 a, Nov. 2	Nov. 3	29.55	SE.	Var. 2	NW.	W, 10	SE–W–NW.
Gonzenheim, Ger. S. S.	Newcastle on Tyne.	Botwood, Newfoundland.	51 52 N	49 43 W	Nov. 2	6 a, 3		29.42	WSW.	SW, 7		S, 10	SSW–SW.
Shenandoah, Am. T. S.	Preston, England.	New York	46 47 N	41 20 W	do	Noon, 2	Nov. 5	29.50	NW.	NW, 7	WNW.	NW, 10	NW–WNW.
Marie Leonhardt, Ger. S. S.	Bremen	Searsport, Me.	45 31 N	57 00 W	Nov. 4	1 p., 4	Nov. 4	30.34	NW.	NW, —	NW.	NW, 10	
Forresbank, Br. M. V.	Cornerbrook	Canal Zone	[1]17 00 N	80 00 W	Nov. 5	3 a., 8	Nov. 9	[1]27.96	NE.	NW, 12	SW.	NE, 12	NE–NW–SW.
Atago Maru, Jap. M. V.	Galveston	Cristobal	15 36 N	81 28 W	Nov. 6	Noon, 7	Nov. 8	28.94	NNE.	NW, 11	SE.	WNW, 12	N–NW.
Changuinola, Br. S. S.	Swansea	Kingston	30 20 N	47 54 W	do	4 a., 7	do	29.37	E.	NE, 8	NNW.	NNE, 9	Steady.
Steel Engineer, Am. S. S.	Colon	Houston	Colon breakwater		Nov. 7	Noon, 7	Nov. 9	29.75	SSE.	SSE, 6	WSW.	—, 9	SSE–NW.
Hazelwood, Br. S. S.	Swansea	Montreal	53 54 N	31 50 W	Nov. 8	—, 10	Nov. 11	28.99	W.	SW, 9	NW.	SSW, 10	SSW–SW–W.
Virginia, Hond. S. S.	Boston	Jamaica	18 12 N	76 24 W	do	Noon, —	Nov. 10	29.57	SE.	SE, 8	NNW.	W, 12	S–NW.
Point Sur, Am. S. S.	Lake Charles, La.	Cristobal	21 11 N	83 40 W	do	1 a., 9	Nov. 9	29.64	NE.	NNW, 7		—, 10	NE–SE–NW.
Dresden, Ger. S. S.	New York	Queenstown	51 04 N	19 30 W	Nov. 9	4 p., 9	Nov. 11	29.15	SSW.	ESE, 12	N.	N, 12	
Black Gull, Am. S. S.	do	Antwerp	49 44 N	16 00 W	do	6 a., 11	do	29.18	S.	S, —	SW.	S, 12	S–SW.
El Estero, Am. S. S.	Galveston	Boston	40 50 N	71 00 W	do	8 a., 10	Nov. 10	29.51	NE.	E, 8	S.	E, 11	NE–E–S.
Alexandre Andre, Belg. M. T.	Manchester	Baytown	25 17 N	71 25 W	Nov. 10	8 p., 10	Nov. 11	28.50	SE.	SE, 10	WNW.	NW, 10	SE–W–NW.
Excalibur, Am. S. S.	Mediterranean ports.	New York	41 40 N	36 10 W	do	2 p., 10	Nov. 12	29.14	SSE.	SSE, —		NNW, 10	SSE–NNE.
Nevada, Fr. S. S.	Anvers	New Orleans	36 43 N	29 40 W	do	11 a., 10	Nov. 11	28.86	S.	WNW, 12	NW.	—, 12	Steady.
Oakman, Am. S. S.	Rotterdam	do	27 33 N	68 50 W	Nov. 11	4 p., 11	Nov. 12	28.73	SE.	S, 12	WNW.	WSW, 12	S–WSW.
Alberta, Ital. S. S.	Houston	Palermo	39 18 N	52 10 W	Nov. 13	8 a., 13	Nov. 13	29.39	S.	SSW, 10	W.	SSW, 10	S–SSW–SW.
Bergensfjord, Nor. S. S.	Beyen	New York	51 29 N	44 00 W	Nov. 14	8 a., 14	Nov. 15	29.58	N.	N, —	NNW.	N, 9	Steady.
Europa, Ger. S. S.	English Channel.	do	46 03 N	40 00 W	Nov. 15	3 a., 15	do	29.63	NW.	NW, 7	NNW.	NW, 11	Do.
Yselhaven, Du. S. S.	Mobile	Bremen	41 54 N	43 55 W	do	4 a., 16	Nov. 16	29.87	N.	NNW, 11	N.	NNW, 11	Do.
Adria, Ger. S. S.	Danzig	Baltimore	56 07 N	23 09 W	Nov. 21	1 a., 22	Nov. 23	29.43	W.	W, 10	S.	W, 11	W–WSW.
Fernmoor, Nor. M. S.	Hamburg	Canal Zone	51 50 N	2 29 E	Nov. 22	8 p., 22	Nov. 24	29.54	W.	SW, 9	WNW.	SW, 11	SW–NW.
Independence Hall, Am. S. S.	Bordeaux	New York	45 39 N	47 23 W	Nov. 23	2 p., 23	do	29.68	S.	S, 7	NW.	NNW, 10	SW–W–NNW.
Cold Harbor, Am. S. S.	Liverpool	Boston	51 17 N	11 00 W	Nov. 24	11 a., 24	Nov. 27	29.55	W.	W, 7	W.	NW, 10	W–NW.
President Roosevelt, Am. S. S.	Hamburg	New York	51 20 N	12 18 W	Nov. 25	2 a., 26	do	29.68	SW.	SW, 8	NW.	W, 10	
Solana, Am. S. S.	New York	San Francisco.	32 29 N	74 00 W	do	11 a., 27	do	29.87	N.	NNE, 8	NE.	NNE, 9	Steady.
Independence Hall, Am. S. S.	Bordeaux	New York	42 18 N	63 05 W	Nov. 26	7 p., 26	Nov. 28	29.72	N.	N, 7	NE.	N, 9	N–NE.
San Juan, Am. S. S.	New York	San Juan	31 18 N	71 07 W	do	8 p., 28	do	29.90	NNE.	NE, 8	NE.	NE, 10	Steady.
Executive, Am. S. S.	Lisbon	New York	36 30 N	66 00 W	do	2 p., 29	Nov. 30	29.30	SSE.	N, 10	NW.	NW, 11	NE–NW.
Luna, Du. S. S.	Maracaibo	do	32 25 N	75 00 W	Nov. 27	10 p., 27	Nov. 28	29.88	NE.	NE, 5	NE.	NE, 11	
Roma, Ital. S. S.	Gibraltar	do	38 12 N	55 42 W	Nov. 28	2 a., 28	Nov. 30	29.89	NE.	NNE, 9	NW.	NNW, 9	N–NNW.
Chincha, Am. S. S.	Cape Town	St. John	40 00 N	60 30 W	Nov. 30	2 a., 30	Dec. 1	29.78	SSE.	SSE, 7	SW.	SSW, 9	SSE–SW.
NORTH PACIFIC OCEAN			° ′	° ′									
Iwatesan Maru, Jap. S. S.	San Francisco	Osaka, Japan	45 50 N	159 00 E	Nov. 2	1 p., 2	Nov. 2	29.54	SW.	W, 9	WNW.	W, 9	4 pts.
Tacoma, Am. S. S.	Tabaco, P. I.	Los Angeles	38 33 N	134 45 W	Nov. 3	9.30 p., 3	Nov. 3	29.67	SSE.	S, 10	SSW.	S, 10	S–SSW.
Kurama Maru, Jap. M. S.	Yokohama	do	40 30 N	133 40 W	do	10 p., 3	Nov. 4	29.49	WSW.	S, 10	WSW.	S, 11	S–SW.
Batoe, Du. S. S.	Ternate, D. E. I.	Portland, Oreg.	42 35 N	129 25 W	do	5 —, 4	Nov. 5	29.46	S.	SW, 8	SSE.	S, 9	S–SW–W.
Edda, Ital. S. S.	Portland, Oreg.	Balboa	40 58 N	125 07 W	Nov. 4	3 p., 3	Nov. 4	29.78	SSE.	S, 9	S.	S, 9	
Empress of Russia, Can. S. S.	Vancouver	Yokohama	52 02 N	142 10 W	Nov. 7	2.30 p., 7	Nov. 8	28.81	ESE.	WSW, 9	W.	WSW, 9	SSW–WSW–W.
President Cleveland, Am. S. S.	Victoria	do	43 52 N	152 09 E	do	12 a., 8	Nov. 9	29.31	ESE.	SSW, 8	WSW.	WSW, 9	SSW–SW–WSW.
Ayaha Maru, Jap. S. S.	Miike	Vancouver	50 50 N	162 30 W	Nov. 8	6 a., 9	Nov. 10	[1]28.88	N.	N, 11	NE.	N, 12	N–NE.
Do	do	do	50 55 N	154 35 W	Nov. 10	1 a., 12	Nov. 12	[1]29.14	W.	WSW, 8	WNW.	WSW, 8	WSW–SW.
President Jefferson, Am. S. S.	Yokohama	Puget Sound	50 00 N	155 50 W	Nov. 12	10 a., 12	Nov. 13	29.47	WNW.	WNW, 8	WNW.	WNW, 9	Steady.
Yarraville, Br. T. S.	Shanghai	San Francisco	42 22 N	169 12 W	do	2 p., 14	Nov. 14	28.49	ENE.	S, 2	SSE.	NE, 8	ENE–NE–S.
Hikawa Maru, Jap. M. S.	Vancouver	Yokohama	42 36 N	152 53 E	Nov. 13	6 a., 14	do	[1]28.90	ESE.	W, —	NW.	—, 12	NW.
Edda, Ital. S. S.	Portland, Oreg.	Balboa	14 10 N	96 56 W	do	8 p., 13	do	29.86	NE.	ENE, —	N.	NNE, 9	
Empress of Asia, Can. S. S.	Yokohama	Vancouver	37 27 N	145 23 E	do	Noon, 13	Nov. 15	[1]29.88	NNW.	NNW, 8	NNE.	NNW, 9	NNW–N.
Yeiyo Maru, Jap. Tank.	San Luis Obispo.	Tokuyama	40 53 N	159 15 E	do	11 p., 13	Nov. 14	[1]28.62	SE.	WNW, 8	NNE.	ESE, 10	W–WNW–NW.
California, Am. Tank	San Pedro	Taku Bar, China.	32 00 N	137 00 E	do	2.10 p., 14	Nov. 15	28.31	ENE.	SE, 12	WNW.	NW, 12	SE–NW.
San Diego Maru, Jap. T.	Los Angeles	Yokohama	31 21 N	171 58 W	do	2 p., 14	do	[1]29.26	SW.	W, 7	W.	SSW, 8	S–SW–W.
Kinkasan Maru, Jap. S. S.	Yokohama	Honolulu	33 56 N	169 56 E	do	4 p., 14	Nov. 16	[1]29.47	SW.	WNW, 9	N.	NW, 9	SW–S–W.
Silverbelle, Br. M. V.	Manila	Los Angeles	43 50 N	166 00 W	do	4 p., 14	Nov. 17	[1]29.75	NNE.	E, 8	S.	S, 9	NNE–E–SE.
President Hayes, Am. S. S.	San Francisco	Honolulu and Kobe.	33 12 N	144 44 E	Nov. 14	Noon, 15	Nov. 15	29.35	E.	W, —	WNW.	—, 10	
San Luis Maru, Jap. T.	Monterey	Yokohama	34 55 N	140 22 E	do	0.30 a., 15	do	28.09	E.	S, 11	NW.	S, 11	SE–S–SW.
Empress of Russia, Can. S. S.	Vancouver	do	42 10 N	146 15 E	Nov. 15	5 p., 15	Nov. 16	29.15	ESE.	NE, 9	W.	N, 10	ENE–NE–N.
Oregon, Am. S. S.	Vladivostok	San Francisco	44 23 N	152 15 E	do	10 p., 16	Nov. 17	29.30	SE.	W, 8	W.	NE, 10	
Ensley City, Am. S. S.	Balboa	Los Angeles	14 25 N	94 01 W	Nov. 19	4 p., 19	Nov. 20	29.83	N.	N, 8	NE.	NNE, 8	N–NNE.
Alaska, Am. S. S.	Seattle	Seward, Alaska.	60 30 N	146 40 W	Nov. 24	8 a., 24	Nov. 25	[1]28.84	NE.	NE, 7	SSE.	NE, 9	SSE.–NE.
President Madison, Am. S. S.	Yokohama	Victoria	50 00 N	151 00 W	do	4 p., 26	Nov. 26	29.41	W.	N, 8	N.	NNW, 9	W–NW–N.
Do	do	do	50 00 N	139 40 W	Nov. 27	6 p., 27	Nov. 27	29.30	NNE.	NW, 10	WNW.	NW, 10	NNE–N–NW.
China Arrow, Am. Tank.	Balboa	San Pedro	15 10 N	93 09 W	Nov. 28	5 p., 28	Nov. 29	29.85	N.	N, 5	N.	N, 9	Steady.
Mojave, Am. Tank	Portland, Oreg.	Port San Luis.	43 00 N	124 49 W	do	4 a., 29	do	29.64	SSE.	S, 8	S.	S, 8	SSE–S.
Ohioan, Am. S. S.	New York	Los Angeles	15 00 N	94 00 W	Nov. 30	6 a., 30	Nov. 30	29.91	NNW.	N, 6	ENE.	NNW, 9	
Golden Sun, Am. S. S.	Otaru	San Francisco	49 13 N	176 50 W	Nov. 29	10 p., 29	Dec. 1	28.81	SW.	SW, 5	W.	W, 8	Steady.

[1] Barometer uncorrected.

[2] Approximate.

NORTH PACIFIC OCEAN, NOVEMBER, 1932

By WILLIS E. HURD

Atmospheric pressure.—The center of the Aleutian LOW during November, 1932, lay over the northwestern part of the Gulf of Alaska. Here the average pressure was below the normal, although in the adjacent part of the Bering Sea it was considerably above.

The crest of the oceanic high-pressure region lay off the California coast, and a narrow anticyclonic belt extended thence across the ocean in southern waters of the temperate zone, widening toward the Asiatic coast, where the continental HIGHS extended seaward over Japan and the neighboring islands to the southward.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, November, 1932, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	30.18	+0.19	30.68	10, 11	29.68	28
Dutch Harbor	29.71	+.12	30.32	1	28.66	30
St. Paul	29.81	+.25	30.14	26, 28	28.90	30
Kodiak	29.51	−.05	30.24	9	28.50	24
Juneau	29.67	−.09	30.47	10	28.82	5
Tatoosh Island	29.96	−.01	30.48	10	29.17	1
San Francisco	30.11	+.02	30.33	5	29.88	26
Mazatlan	29.92	−.04	30.00	20, 21, 27	29.82	9
Honolulu	30.01	−.01	30.16	29	29.82	18
Midway Island	30.00	−.08	30.16	18	29.54	14
Guam	29.84	−.02	29.90	17, 30	29.74	8
Manila	29.81	−.08	29.96	17	29.52	10
Naha	30.04	+.06	30.28	18	29.58	12
Chichishima	30.02	+.04	30.26	18	29.72	14
Nemuro	29.97	-------	30.28	3, 5	29.48	15

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—During November a succession of cyclones, many of them accompanied by snow, appeared on the northern part of the North Pacific, but a concentration of cyclonic activity occurred in the Gulf of Alaska. In consequence of the barometrically depressed condition in northeastern waters and the frequent extension of low pressure into middle latitudes, fresh to whole gales were experienced on several days to the eastward of 170° W. by northern-route vessels. High winds were reported off the Washington and Oregon coasts on three or four days during the existence of these far-reaching LOWS. The heaviest winds of the month thus far reported in connection with extratropical cyclones were those of the 3d–4th—maximum force 11—near latitude 40° N., longitude 134° W., and that of the 10th—force 12—near 51° N., 163° W.

In east longitudes less than the usual amount of stormy weather for the month, associated with higher-latitude cyclones, seems to have occurred. The region of most frequent storminess lay southeast of the Kuril Islands. In midocean an extensive depression occurred near the middle of November. It reached far southward and on the 14th caused a barometric fall to 29.54 inches at Midway Island. On this day scattered gales of force 8–9 were reported from an enormous area between latitudes 30° and 45° N., longitudes 165° E. and 165° W.

Typhoon of November 7–16.—About November 7 a depression appeared east of the Philippine Islands. From the 8th to 11th it affected the central and northern part of the archipelago as it slowly moved northward. The lowest pressure at Manila occurred on the 10th and at Naha on the 12th. On the 13th the typhoon lay south of Kiushu Island, Japan, developing rapidly. On the 14th and 15th it went up the east Japanese coast, causing full-storm to hurricane velocities over the near-by sea, and on the 16th, south of the Kurils, was working rapidly toward the Aleutians. Among the vessels involved in this storm the American tankship *California* perhaps bore the fullest brunt of it. She passed through the typhoon center in 32° N., 137° E., on the afternoon of the 14th, lowest barometer 28.31 inches. The wind there dropped from a southeast hurricane to variable puffs, force 2. During the relative calm, numbers of ducks and land birds were observed. On the other side of the center hurricane winds from the northwest were estimated to have a velocity of 125 miles an hour.

Tehuantepecers.—Over and near the Gulf of Tehuantepec norther gales occurred on several days, as follows: Of force 7 on the 6th and 25th; of force 8 on the 19th and 20th; and of force 9 on the 13th, 29th, and 30th.

Fog.—Very little fog was observed far at sea, but off the central California coast it was reported on 10 days, diminishing northward to the Columbia River and southward to Cape San Lucas.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, November, 1932

[For description of tables and charts, see REVIEW, January, p. 37]

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	50.3	−3.9	2 stations	79	8	Valley Head	20	29	3.70	+0.36	Samson	8.40	Union Springs	1.20
Arizona	54.3	+1.9	Agua Caliente	95	8	Fort Defiance	9	[1] 15	0.00	−.97	Bright Angel	.30	108 stations	.00
Arkansas	46.7	−4.7	El Dorado	82	20	Gravette	9	16	1.98	−1.67	Dumas	4.76	Fort Smith	.48
California	55.4	+3.9	3 stations	95	[1] 7	Twin Lakes	−2	3	.94	−1.53	Upper Mattole	17.80	43 stations	.00
Colorado	37.3	+2.0	Las Animas	90	4	Westcliffe	−18	11	.25	−.58	Nast	1.70	13 stations	.00
Florida	63.1	−2.0	5 stations	89	[1] 1	3 stations	24	[1] 13	4.47	+2.23	Belle Glade	12.44	Arcadia	.60
Georgia	52.0	−2.6	Quitman	83	11	Clayton	12	28	4.59	+1.86	Cornelia	7.78	Macon	2.07
Idaho	37.8	+2.8	Milner Dam	77	1	Big Springs	−18	11	2.40	+.28	Roland	12.21	2 stations	.00
Illinois	37.3	−4.8	Carbondale	74	7	Hoopeston	7	[1] 17	1.75	−.74	Mount Carmel	4.36	Freeport	.25
Indiana	38.6	−3.6	2 stations	78	7	Goshen	1	17	2.44	−.66	Greensburg	3.99	Laporte	1.09
Iowa	33.2	−3.1	Washta	67	6	Inwood	−5	19	1.55	−.02	Creston	3.27	Glenwood	.19
Kansas	41.0	−2.6	Johnson	82	30	2 stations	−2	16	.32	−1.04	Olathe	1.58	Lyons	.00
Kentucky	43.8	−2.6	4 stations	78	[1] 6	Quicksand	11	28	2.71	−.86	Burnside	4.66	Pippapass	1.16
Louisiana	53.6	−5.3	Robeline	83	[1] 4	Robeline	20	[1] 12	4.34	+.55	Atchafalaya	9.30	Bogalusa	1.76
Maryland-Delaware	43.5	−1.6	Princess Anne, Md.	72	16	2 stations	2	27	5.25	+2.70	State Sanatorium, Md.	7.85	Crisfield, Md	1.95
Michigan	33.5	−2.9	Lapeer	70	4	Dukes	−8	27	1.69	−.78	Deer Park	4.09	Edenville	.55
Minnesota	26.2	−3.3	Gull Lake Dam	69	6	2 stations	−26	26	1.88	+.66	Pigeon River Bridge	6.86	Beardsley	.18
Mississippi	50.7	−4.4	Yazoo City	80	10	Monticello	21	29	3.66	+.07	Hickory	5.60	Meridian	2.10
Missouri	39.5	−4.9	2 stations	75	[1] 4	Clifton Hill	−9	16	1.82	−.58	Lockwood	3.93	St. Joseph	.59
Montana	34.7	+3.1	Great Falls	71	19	Circle (near)	−29	15	1.09	+.29	Heron	7.35	Valentine	.01
Nebraska	38.0	+1.3	2 stations	79	[1] 13	Santee	−2	15	.15	−.64	Falls City	1.04	14 stations	.00
Nevada	44.4	+4.1	Logandale	91	9	Zorra Vista Ranch	4	[1] 3	.14	−.54	Mahoney Ranger Station.	1.45	20 stations	.00
New England	36.6	−1.4	Lawrence, Mass	70	6	Pittsburg, N. H	−9	27	5.38	+1.91	Mays Mills, Mass	8.69	Eastport, Me	1.65
New Jersey	42.0	−.7	Hammonton	71	16	Layton	3	29	7.81	+4.53	Little Falls	12.66	Atlantic City	3.92
New Mexico	42.9	+.3	Artesia	90	7	2 stations	−3	11	.01	−.64	Des Moines	.37	122 stations	.00
New York	36.1	−1.7	Setauket	69	8	do	−11	[1] 23	4.95	+1.93	Rifton	9.28	Andover	1.78
North Carolina	48.2	−1.7	2 stations	79	[1] 1	Altapass	5	28	5.17	+2.58	Hatteras	11.42	Banners Elk	1.84
North Dakota	25.2	−2.2	McLeod	70	7	Richardson	−17	15	.49	−.12	Hansboro	2.69	2 stations	T.
Ohio	39.2	−2.2	McConnelsville	80	7	Paulding	−1	22	3.09	+.34	2 stations	4.57	Batavia	1.29
Oklahoma	46.5	−3.5	Durant	87	7	3 stations	8	16	.43	−1.64	Miami	1.75	5 stations	.00
Oregon	43.3	+2.7	Brookings	78	17	Harney Branch	3	3	4.21	+.40	Headworks	19.28	2 stations	.35
Pennsylvania	39.4	−1.8	2 stations	75	7	Kane	−2	27	4.75	+1.89	Doylestown	9.11	Clymer	2.30
South Carolina	51.2	−2.5	Kingstree	81	16	Cherokee (near)	16	29	4.45	+2.11	Gaston Shoals	8.28	Columbia	1.87
South Dakota	33.8	+.7	3 stations	75	[1] 24	Britton	−13	15	.21	−.48	Millbank	1.20	5 stations	.00
Tennessee	45.9	−2.7	McKenzie	80	7	Erwin	11	28	3.20	−.41	Copperhill	7.24	Franklin	1.39
Texas	53.1	−4.1	Hebbronville	95	10	Booker	10	15	.83	−1.49	Dialville	6.29	30 stations	.00
Utah	39.8	+2.3	St. George	79	19	Soldier Summit	2	11	.36	−.69	Silver Lake	2.16	27 stations	.00
Virginia	44.8	−1.7	2 stations	78	7	Mount Weather	9	27	4.33	+1.99	Culpeper	8.53	Langley Field	1.65
Washington	42.1	+2.9	do	73	17	Stockdill Ranch	12	26	8.45	+3.36	Big Four	37.15	Hanford	.65
West Virginia	40.9	−2.0	Robertsburg	85	8	Bayard	0	27	3.34	+.18	Kearneysville	6.27	Dam No. 6, Kanawha River.	.89
Wisconsin	30.0	−3.4	Blair	69	[1] 6	Long Lake	−19	16	1.86	+.11	Solon Springs	4.20	Mellen	.45
Wyoming	34.3	+3.3	Clark	78	27	South Pass City	−24	11	.53	−.27	Bechler River	3.77	4 stations	T.
Alaska (October)	32.0	+1.4	Ketchikan	69	3	Barrow	−12	31	3.02	−.33	View Cove	18.79	Fort Yukon	.12
Hawaii	72.7	+.8	Mahukona	91	11	Kanalohuluhulu	46	[1] 11	6.93	−1.33	Hilo-Manawaiopuna Divide.	26.00	Lahaina	.08
Puerto Rico	77.3	+.8	Bayamon	95	11	Guineo Reservoir	49	29	6.48	−.94	La Fe	16.51	Santa Rita	.00

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau Stations, November, 1932*

[Compiled by Annie E. Small]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F*		°*F*	°*F*		°*F*	° *F.*	° *F.*	° *F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							39.4	−0.1										74	4.55	+1.3										6.0		
Eastport	76	67	85	30.10	30.18	+0.17	37.0	+0.3	56	17	44	4	27	30	40	34	31	78	1.65	−1.7	11	9,718	sw.	38	se.	10	3	7	20	7.7	T.	0.0
Greenville, Me	1,070	6	----	28.99	30.19	------	34.9	------	54	6	38	−3	27	32	35	----	----	---	5.01	------	12	5,625	se.	25	------	18	8	10	12	----	2.2	----
Portland, Me	103	82	117	30.07	30.19	+.18	39.0	+1.0	62	5	47	8	27	31	33	34	29	70	4.57	+1.1	8	7,735	n.	48	s.	19	12	8	10	5.1	T.	.0
Concord	289	70	79	29.88	30.20	+.14	35.4	−2.3	61	5	46	4	28	25	36	----	----	---	3.89	+.8	9	4,392	nw.	25	ne.	10	12	7	11	5.1	.2	.0
Burlington	403	11	48	29.75	30.21	+.16	33.2	−3.1	57	5	41	6	28	26	37	----	----	---	3.83	+1.2	9	8,323	s.	32	se.	9	5	6	19	7.1	3.1	T.
Northfield	876	12	60	29.24	30.23	+.18	31.8	−1.0	56	6	42	0	28	22	43	27	24	80	5.51	+2.6	13	5,877	s.	23	s.	1	2	11	17	7.4	.7	.0
Boston	125	106	165	30.05	30.19	+.14	42.8	+.8	66	16	51	8	27	34	42	38	31	68	5.24	+1.9	9	7,032	nw.	28	s.	19	9	11	10	5.1	T.	.0
Nantucket	12	14	90	30.14	30.15	+.10	46.4	+2.0	63	16	52	22	27	40	29	43	40	79	4.72	+1.5	10	12,878	n.	51	e.	10	7	7	16	6.8	T.	.0
Block Island	26	11	46	30.14	30.17	+.11	44.4	−.2	62	16	51	14	27	38	37	42	38	78	3.78	+.2	9	14,192	n.	59	e.	10	9	7	14	5.8	.0	.0
Providence	160	215	251	30.01	30.19	+.12	41.6	+1.2	63	16	50	9	27	33	40	37	30	66	4.49	+1.4	9	9,460	nw.	44	se.	1	13	5	12	4.8	.0	.0
Hartford	159	122	----	30.03	30.21	+.13	40.4	+.9	62	19	49	10	27	32	37	----	----	---	5.96	+2.4	10	------	n.	----	----	---	11	9	10	5.4	T.	.0
New Haven	106	74	153	30.08	30.20	+.13	41.7	−.3	62	16	50	12	27	33	36	38	33	74	6.45	+3.1	10	7,776	n.	34	s.	19	11	10	9	5.2	.0	.0
Middle Atlantic States							43.8	−1.0										73	4.91	+2.4									5.4		
Albany	97	107	115	30.11	30.22	+.14	37.8	−1.5	58	5	46	9	27	30	35	34	29	73	5.41	+2.6	10	5,840	s.	23	s.	23	10	6	14	5.8	T.	.0
Binghamton	871	60	68	29.25	30.20	+.11	36.9	−1.8	60	16	46	7	23	28	37	----	----	---	3.39	+1.0	12	4,657	nw.	25	nw.	26	5	5	20	7.2	.1	.0
New York	314	414	454	29.84	30.19	+.10	43.7	−.5	61	1	51	12	27	36	36	39	33	68	5.87	+2.9	10	11,349	n.	56	nw.	1	11	8	11	5.1	.0	.0
Bellefonte	1,050	5	42	29.06	30.20	------	36.4	------	59	15	47	7	27	26	40	32	28	79	3.45	------	9	------	sw.	----	----	---	8	8	14	6.1	.1	.0
Harrisburg	374	94	104	29.80	30.21	+.10	41.2	−1.6	62	16	49	17	27	33	32	36	30	68	4.88	+2.6	11	5,281	w.	25	e.	9	10	10	10	5.6	T.	.0
Philadelphia	114	123	367	30.08	30.21	+.11	45.8	+.1	67	16	53	16	27	38	33	40	33	65	7.45	+4.8	11	10,205	n.	42	ne.	10	11	9	10	5.0	T.	.0
Reading	323	283	304	29.85	30.22	------	41.6	−.9	62	16	50	14	27	34	33	37	31	69	5.71	+3.0	11	5,275	nw.	34	se.	9	10	8	12	5.6	T.	.0
Scranton	805	72	103	29.35	30.24	+.15	38.4	−2.1	64	16	47	8	27	29	38	34	30	75	4.40	+1.6	8	5,103	n.	41	se.	10	7	10	13	5.8	T.	.0
Atlantic City	52	37	172	30.13	30.19	+.09	46.4	+.8	66	1	54	17	27	39	35	43	38	75	3.92	+1.1	8	12,883	nw.	60	e.	9	10	6	14	5.7	.0	.0
Sandy Hook	22	10	55	30.16	30.18	------	44.3	------	61	19	50	17	27	38	29	41	36	75	5.58	+2.3	11	11,896	ne.	56	sw.	1	12	5	13	5.4	T.	.0
Trenton	190	159	183	29.99	30.20	------	43.0	−1.4	66	16	52	12	27	34	33	38	34	75	7.53	+4.8	11	8,435	n.	42	nw.	1	12	8	10	5.0	T.	.0
Baltimore	123	100	215	30.06	30.20	+.09	45.8	−.5	68	5	54	19	27	38	33	40	34	69	6.17	+3.6	11	7,903	n.	44	ne.	9	13	8	9	5.0	T.	.0
Washington	112	62	85	30.08	30.20	+.08	44.7	−.5	68	5	54	18	27	36	35	39	33	70	6.43	+4.1	11	5,577	nw.	28	nw.	1	12	9	9	5.2	.0	.0
Cape Henry	18	8	54	30.15	30.17	------	51.2	−.9	72	1	58	27	27	45	25	47	44	79	3.56	+1.2	7	10,846	n.	43	n.	26	14	2	14	5.4	T.	.0
Lynchburg	681	153	188	29.44	30.20	+.07	45.1	−2.1	68	25	56	16	28	35	35	39	34	72	4.63	+2.3	9	4,827	nw.	25	ne.	26	15	4	11	4.6	.0	.0
Norfolk	91	170	205	30.09	30.19	+.08	51.6	+.2	73	25	59	27	27	44	29	46	42	75	2.34	+.2	8	9,173	n.	39	n.	26	14	3	13	5.3	T.	.0
Richmond	144	11	52	30.05	30.21	+.09	46.8	−1.5	71	25	57	19	27	37	35	41	37	77	3.50	+1.3	10	5,921	ne.	26	ne.	26	13	7	10	4.4	.0	.0
Wytheville	2,304	49	55	27.77	30.22	+.09	40.6	−2.4	65	5	51	12	28	30	36	35	31	74	2.74	+.6	9	4,793	e.	22	w.	11	12	5	13	5.3	T.	.0
South Atlantic States							52.7	−1.4										75	4.10	+1.7									4.9		
Asheville	2,253	89	104	27.79	30.21	+.07	44.0	−1.1	73	7	55	16	28	33	38	38	33	74	3.03	+.8	10	6,385	nw.	25	nw.	19	13	8	9	4.7	T.	.0
Charlotte	779	244	267	29.34	30.19	+.06	48.0	−2.6	68	7	56	23	28	40	25	42	35	67	2.43	−.1	9	7,415	n.	34	n.	27	15	3	12	4.4	.0	.0
Greensboro	886	6	56	29.23	30.20	------	44.2	------	66	25	55	18	29	34	35	39	35	82	3.73	------	11	5,898	ne.	30	ne.	27	15	3	12	4.7	.0	.0
Hatteras	11	5	50	30.12	30.13	+.02	57.4	+1.1	77	1	63	42	13	52	24	53	50	79	11.42	+7.9	13	10,973	n.	49	ne.	26	7	7	16	6.8	.0	.0
Raleigh	376	103	146	29.78	30.19	+.06	49.1	−1.9	71	16	58	22	27	40	33	43	37	70	3.58	+1.3	10	6,866	ne.	32	ne.	27	13	7	10	4.7	.0	.0
Wilmington	72	73	106	30.08	30.16	+.04	54.3	−1.7	76	9	64	30	27	45	31	49	46	79	6.51	+4.6	11	6,698	n.	30	se.	1	15	4	11	4.3	.0	.0
Charleston	48	11	92	30.08	30.13	+.01	56.8	−1.3	74	1	64	33	28	49	25	52	48	78	2.24	+.1	7	8,756	ne.	37	n.	26	12	5	13	5.1	.0	.0
Columbia, S. C	351	41	57	29.78	30.17	+.05	51.8	−2.2	73	16	61	26	29	42	31	46	40	72	1.87	−.1	8	5,446	ne.	24	ne.	26	12	8	10	4.5	.0	.0
Greenville, S. C	1,039	139	146	29.06	30.18	------	48.6	−1.0	70	7	57	25	28	40	29	42	37	71	3.78	+.6	11	6,941	ne.	28	ne.	27	16	4	10	4.1	.0	.0
Augusta	182	62	77	29.95	30.15	+.02	53.2	−1.3	75	16	63	29	28	43	38	46	42	74	2.47	+.1	7	4,773	ne.	25	ne.	26	13	6	11	4.9	.0	.0
Savannah	65	73	152	30.06	30.13	+.01	56.8	−1.7	77	16	66	32	30	47	32	51	48	79	2.27	+.2	8	8,011	n.	32	n.	26	12	4	14	5.2	.0	.0
Jacksonville	43	209	245	30.05	30.10	.00	60.0	−2.2	79	6	67	34	29	52	25	54	50	76	5.55	+3.6	13	8,601	ne.	37	nw.	1	11	7	12	5.4	.0	.0
Florida Peninsula							68.8	−2.2										79	3.46	+1.2									5.0		
Key West	22	10	64	29.99	30.01	−.01	72.2	−2.1	86	7	77	56	14	67	17	67	64	78	2.77	+0.6	11	7,941	ne.	29	n.	13	11	12	7	5.0	.0	.0
Miami	25	124	168	30.00	30.03	−.03	69.7	−2.1	84	1	76	47	14	63	27	64	61	76	6.14	+3.2	15	8,699	nw.	25	ne.	3	9	10	11	5.5	.0	.0
Tampa	35	88	197	30.03	30.07	−.01	64.4	−2.5	85	6	73	38	30	56	30	58	56	83	1.47	−.2	9	8,496	ne.	31	nw.	19	12	11	7	4.7	.0	.0
Titusville	44	5	----	30.00	30.05	------	64.8	------	86	1	73	39	13	56	29	----	----	---	4.43	------	12	------	nw.	----	----	---	12	12	6	4.6	.0	.0
East Gulf States							52.0	−4.1										74	3.13	−.1									4.5		
Atlanta	1,173	190	198	28.91	30.17	+.04	47.8	−4.3	68	8	56	28	13	40	25	42	35	66	2.96	−.1	12	8,494	e.	31	nw.	11	15	2	13	4.7	.0	.0
Macon	370	76	84	29.76	30.17	+.04	51.6	−2.6	73	16	62	26	29	42	34	45	40	71	2.07	−.4	9	5,418	ne.	22	ne.	26	12	6	12	5.2	.0	.0
Thomasville	273	49	103	29.83	30.13	+.01	56.0	−2.5	75	16	66	31	29	46	30	49	46	79	3.12	+.4	11	6,295	ne.	23	se.	18	14	2	14	4.9	.0	.0
Apalachicola	36	11	51	30.08	30.12	------	57.2	------	77	7	65	34	29	50	28	53	50	80	5.94	+2.9	10	7,019	ne.	24	ne.	3	13	6	11	4.6	.0	.0
Pensacola	56	149	185	30.08	30.14	+.03	54.6	−5.6	76	8	62	34	12	47	30	51	48	83	1.57	−2.1	6	9,294	ne.	35	e.	25	14	5	11	4.6	.0	.0
Anniston	741	9	57	----	----	----	49.0	−2.9	73	8	60	26	20	38	34	----	----	---	3.98	------	12	------	nw.	----	----	---	13	3	14	----	.0	.0
Birmingham	700	11	48	29.40	30.19	+.07	49.4	−4.5	74	5	59	27	13	40	31	42	36	69	4.73	+1.4	10	5,379	e.	23	s.	10	14	8	8	4.4	.0	.0
Mobile	57	125	161	30.08	30.14	+.03	54.2	−4.4	74	8	63	34	28	46	28	49	45	79	2.41	−1.2	5	6,979	n.	29	n.	26	13	6	11	4.7	.0	.0
Montgomery	223	100	112	29.93	30.18	+.06	51.4	−4.4	75	8	60	31	13	42	32	45	39	70	1.77	−1.5	12	5,552	ne.	24	n.	26	13	4	13	5.0	.0	.0
Corinth	469	6	----	----	----	----	48.6	------	75	7	60	24	13	38	35	----	----	---	3.34	------	10	------	se.	----	----	---	12	9	9	----	.0	.0
Meridian	375	87	95	29.77	30.18	+.06	50.5	−3.7	71	5	60	27	29	41	36	43	39	74	2.10	−1.2	10	4,646	ne.	21	nw.	10	15	6	9	4.1	.0	.0
Vicksburg	247	65	73	29.92	30.18	+.06	51.4	−5.2	76	7	61	30	16	42	31	45	39	71	4.10	+.4	11	5,698	ne.	21	nw.	15	17	7	6	3.6	.0	.0
New Orleans	53	76	84	30.10	30.16	+.06	56.2	−5.4	74	21	64	36	17	49	26	50	45	74	3.62	+.5	9	5,626	ne.	20	e.	24	15	6	9	4.2	.0	.0
West Gulf States							54.1	−3.6										68	1.24	−1.6									3.2		
Shreveport	249	92	227	29.92	30.20	+.09	52.4	−3.6	80	7	64	24	16	41	41	46	41	73	1.98	−1.7	5	8,770	ne.	33	nw.	15	20	5	5	3.2	0	.0
Bentonville	1,303	11	44	28.76	30.15	+.04	43.4	−3.3	71	7	55	12	16	32	44	----	----	---	2.23	------	8	4,948	s.	21	s.	14	15	4	11	----	1.8	.0
Fort Smith	457	79	94	29.68	30.18	+.07	47.8	−3.2	76	7	59	20	16	37	39	40	33	65	.48	−2.4	5	5,800	e.	22	nw.	8	13	10	7	4.6	.0	.0
Little Rock	357	136	153	29.81	30.20	+.08	47.4	−4.7	74	4	57	25	16	38	40	40	33	64	1.23	−3.0	7	6,900	n.	27	s.	15	13	6	11	5.1	.0	.0
Austin	605	136	148	29.53	30.17	------	55.5	−3.0	83	7	69	28	16	42	42	46	37	58	1.26	−1.0	4	6,156	n.	30	s.	14	19	5	6	2.8	.0	.0
Brownsville	57	83	100	30.08	30.14	------	63.8	−3.4	83	4	73	42	18	55	30	56	52	74	.59	−1.4	4	7,257	nw.	30	nw.	15	20	8	2	2.7	.0	.0
Corpus Christi	20	11	78	30.15	30.17	+.10	60.8	−3.5	88	10	70	38	16	51	32	54	49	73	.90	−1.1	6	7,757	n.	30	n.	15	20	6	4	2.8	.0	.0
Dallas	512	220	227	29.62	30.18	------	52.0	------	82	7	63	22	16	41	36	----	----	---	.31	−2.2	2	8,767	nw.	43	nw.	7	22	3	5	2.5	T.	.0
Fort Worth	670	106	114	29.45	30.18	+.08	52.4	−3.1	84	7	65	24	16	40	38	45	38	65	1.56	−1.0	3	6,148	nw.	26	sw.	14	19	4	7	2.4	.0	.0
Galveston	54	106	114	30.11	30.17	+.08	58.3	−5.0	77	7	65	36	16	52	30	53	49	76	2.51	.8	6	8,111	n.	30	nw.	8	19	7	4	2.9	.0	.0
Houston	138	292	314	30.03	30.18	------	57.0	−4.0	81	7	67	28	16	47	39	----	----	---	1.20	−2.6	5	9,653	n.	32	n.	8	19	4	7	3.1	.0	.0
Palestine	510	64	72	29.65	30.20	+.09	53.2	−4.0	80	7	64	23	16	42	36	45	38	62	1.65	−1.8	4	6,036	s.	26	sw.	10	19	5	6	3.2	.0	.0
Port Arthur	34	58	66	30.12	30.16	------	56.0	------	78	5	65	31	16	47	34	50	46	77	2.05	−1.0	7	6,422	s.	25	n.	16	17	8	5	4.0	.0	.0
San Antonio	693	242	301	29.43	30.15	+.07	57.8	−2.5	83	10	70	28	16	46	34	48	39	56	.10	−1.8	3	8,675	n.	40	n.	23	19	8	3	2.6	.0	.0
Taylor	571	38	51	29.60	30.20	+.12	54.0	−3.7	82	7	67	26	16	41	40	----	----	---	1.59	.8	4	6,388	nw.	30	sw.	14	20	6	4	2.6	.0	.0

TABLE I.—*Climatological data for Weather Bureau Stations, November, 1932*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							42.8	−2.5										72	2.75	−0.4										5.6		
Chattanooga	762	190	215	29.38	30.20	+0.06	47.4	−3.0	73	7	56	29	29	39	29	41	35	65	4.94	+1.6	10	5,945	ne.	27	w.	8	15	6	9	4.3	T.	0.0
Knoxville	995	79	97	29.12	30.20	+.07	45.9	−2.0	76	7	56	26	20	36	30	40	34	69	3.22	+.2	9	4,487	ne.	21	sw.	16	15	5	10	4.3	T.	.0
Memphis	399	78	86	29.76	30.20	+.08	47.4	−4.3	70	3	56	27	16	39	40	42	38	75	4.15	−.1	6	6,139	ne.	27	nw.	15	14	3	13	5.0	T.	.0
Nashville	546	168	191	29.62	30.22	+.10	46.6	−2.4	72	7	56	26	27	37	28	41	36	74	1.88	−1.6	10	6,570	ne.	31	w.	10	11	5	14	5.2	T.	.0
Lexington	989	193	230	29.13	30.23	+.11	42.6	−2.2	70	7	51	18	27	34	30				2.09	−1.2	12	9,144	s.	32	sw.	16	12	7	11	4.8	.4	.0
Louisville	525	188	234	29.62	30.22	+.10	43.0	−3.7	74	8	51	22	27	35	35	38	34	74	1.91	−1.7	10	7,315	s.	30	n.	26	9	6	15	6.2	T.	.0
Evansville	431	76	116	29.73	30.21	+.09	42.8	−3.8	71	7	50	24	27	35	26	38	33	71	2.11	−1.6	7	6,715	s.	30	sw.	14	12	2	16	5.6	2.3	.0
Indianapolis	822	194	230	29.29	30.20	+.10	38.0	−4.3	70	8	46	16	17	30	33	33	27	70	2.69	−.7	9	7,805	s.	28	s.	8	9	6	15	6.0	9.8	.0
Terre Haute	575	96	129	29.56	30.19		38.6		67	7	47	17	20	30	30	34	29	74	2.80	−.5	10	6,965	s.	26	n.	16	14	3	13	5.1	6.2	.0
Cincinnati	627	11	51	29.51	30.21	+.09	41.2	−1.3	74	8	49	19	27	33	29	36	32	75	2.01	−.8	9	5,661	s.	25	n.	26	10	7	13	5.9	.5	.0
Columbus	822	216	230	29.30	30.20	+.09	41.0	−.9	70	8	49	17	27	33	22	36	31	72	2.07	−.7	9	7,633	s.	27	n.	26	8	8	14	6.2	T.	.0
Dayton	899	137	173	29.23	30.21		40.2	−1.8	73	8	48	19	27	33	25	35	31	74	2.64	−.2	11	6,481	sw.	27	ne.	26	9	9	12	6.1	2.6	.0
Elkins	1,947	59	67	28.13	30.26	+.14	39.4	−.9	72	7	52	9	28	27	41	33	29	79	2.81	.0	10	3,921	w.	20	w.	11	11	4	15	6.0	.7	.0
Parkersburg	637	77	82	29.56	30.24	+.12	41.9	−1.9	75	8	52	15	27	32	31	36	31	72	2.71	+.1	11	4,345	se.	19	sw.	11	9	4	17	6.5	T.	.0
Pittsburgh	842	353	410	29.29	30.22	+.12	41.2	−2.0	68	8	50	12	27	32	28	36	30	69	3.22	+.9	8	6,924	w.	27	w.	1	8	11	11	6.1	T.	.0
Lower Lake Region							37.4	−2.0										74	2.78	.0									6.8		
Buffalo	767	243	280	29.33	30.19	+.14	37.4	−2.0	58	6	44	13	27	31	24	34	31	79	4.50	+1.5	15	11,443	sw.	50	sw.	11	8	5	17	6.9	15.9	.0
Canton	448	10	61	29.70	30.19		31.9	−2.0	60	6	40	4	27	24	34				4.18	+1.0	13	6,808	sw.	30	sw.	25	6	11	13	6.4	6.0	.0
Ithaca	836	74	100	29.27	30.20		38.2	−.4	59	15	47	10	27	30	31	33	28	72	2.26	−.1	12	7,689	nw.	38	e.	10	6	4	20	7.3	.7	.0
Oswego	335	71	85	29.82	30.20	+.15	37.2	−1.7	59	6	44	10	27	30	29	33	28	73	2.98	−.4	14	8,255	s.	34	se.	9	6	3	21	7.4	.6	.0
Rochester	523	86	102	29.62	30.21	+.16	37.7	−1.0	61	6	44	16	27	31	26	33	28	69	3.56	+1.0	16	6,347	sw.	24	sw.	25	7	2	21	7.3	5.0	.0
Syracuse	596	65	79	29.54	30.21	+.15	38.0	−.7	60	6	46	9	27	30	34				2.58	−.2	14	5,555	s.	28	nw.	26	7	5	18	7.3	2.1	.0
Erie	714	130	166	29.40	30.19	+.13	39.2	−2.2	61	4	46	19	27	32	23	35	30	73	3.13	−.2	13	9,015	s.	45	se.	9	7	9	14	6.8	3.3	.0
Cleveland	762	267	337	29.34	30.18	+.11	40.4	−.5	65	4	47	20	27	34	25	35	29	68	2.63	.0	12	10,415	s.	38	se.	8	6	6	18	7.0	2.0	.0
Sandusky	629	5	67	29.50	30.20	+.12	38.6	−2.5	63	4	46	17	20	32	24				2.54	+.2	9	7,178	sw.	23	sw.	13	5	6	19	6.9	2.3	.0
Toledo	628	79	37	29.50	30.20	+.13	36.8	−3.6	62	4	44	17	20	30	23	33	28	75	2.12	−.3	6	6,986	sw.	24	w.	11	9	8	13	5.9	12.0	T.
Fort Wayne	857	69	84	29.24	30.19		35.6	−5.0	69	8	43	14	22	28	27	32	28	77	1.18	−1.7	10	6,744	sw.	24	sw.	11	9	6	15	6.0	4.5	T.
Detroit	730	218	258	29.38	30.20	+.14	37.2	−2.1	62	4	43	18	27	31	19	34	31	81	1.72	−.7	10	7,884	sw.	26	sw.	25	6	7	17	6.9	10.1	.0
Upper Lake Region							33.0	−2.4										78	1.93	−.5									7.3		
Alpena	609	13	89	29.47	30.16	+.15	33.3	−1.1	56	5	39	10	27	28	24	30	27	79	0.86	−1.7	13	8,965	nw.	32	se.	9	4	8	18	7.2	2.0	T.
Escanaba	612	54	60	29.44	30.13	+.10	30.2	−2.9	55	5	37	7	19	24	26	28	24	77	2.52	+.4	8	7,888	sw.	29	s.	22	5	7	18	7.3	5.5	.5
Grand Haven	632	54	89	29.45	30.16	+.12	35.0	−3.5	58	8	42	12	27	28	24	33	29	78	2.05	−.7	11	9,064	se.	31	sw.	13	5	7	18	7.6	2.6	.0
Grand Rapids	707	70	244	29.36	30.15	+.10	36.5	−1.9	64	4	43	17	27	30	26	32	26	71	1.62	−1.2	11	9,132	s.	29	w.	25	5	6	19	7.3	4.9	.0
Houghton	668	64	99	29.32	30.07	+.05	29.5	−2.5	54	6	36	9	19	23	30				3.34	+.3	19	6,914	w.	34	w.	20	2	5	23	8.4	15.9	2.0
Lansing	878	6	88	29.20	30.18		34.2	−3.3	64	4	42	11	27	30	29	31	29	89	1.42	−1.1	11	7,504	sw.	24	se.	8	6	8	16	6.8	6.3	.0
Ludington	637	60	66	29.42	30.14		35.5	−1.9	57	7	41	15	27	30	20	33	29	78	1.96	−.7	14	9,135	se.	37	sw.	20	7	5	18	7.0	.9	.0
Marquette	734	77	111	29.27	30.10	+.08	30.9	−2.4	57	6	37	9	19	25	24	28	24	78	1.43	−1.5	15	7,674	s.	35	sw.	27	1	7	22	8.5	5.3	.2
Port Huron	638	79	120	29.46	30.17	+.12	35.8	−1.7	61	7	42	16	27	30	23	32	29	80	1.99	−.4	11	8,818	sw.	30	se.	8	6	7	17	6.9	9.1	T.
Sault Sainte Marie	614	11	52	29.42	30.14	+.13	30.7	−1.3	52	5	37	3	26	24	29	28	26	84	2.59	−.1	18	6,920	se.	30	nw.	25	1	7	22	8.1	13.9	.5
Chicago	673	7	131	29.43	30.18	+.11	37.2	−2.9	63	4	43	17	21	31	25	33	28	71	2.24	−.1	5	8,194	sw.	25	ne.	15	7	7	16	6.7	.6	.0
Green Bay	617	109	141	29.44	30.12	+.08	31.8	−2.2	58	6	39	10	19	25	26	28	22	70	1.01	−1.2	6	8,152	s.	27	s.	22	5	6	19	7.2	.7	.0
Milwaukee	681	97	221	29.39	30.15	+.10	35.2	−2.1	60	6	42	14	21	29	22	31	26	72	.86	−.9	6	9,972	sw.	38	se.	8	7	5	18	6.9	.6	.0
Duluth	1,133	5	47	28.80	30.07	+.03	25.7	−4.3	62	6	34	−10	19	17	32	24	21	83	3.10	+1.6	10	9,690	sw.	44	nw.	11	9	5	16	6.4	2.0	T.
North Dakota							26.1	−.8										82	.51	−.2									6.5		
Moorhead	940	50	58	29.02	30.08	+.01	25.3	−1.8	53	6	34	−10	19	17	34	22	20	85	.84	−.1	8	7,956	s.	27	s.	3	2	10	18	7.4	11.1	.6
Bismarck	1,674	8	57	28.23	30.08	+.01	28.8	+.3	58	24	39	−5	15	19	43	24	20	74	.16	−.4	5	7,233	nw.	34	se.	3	8	12	10	5.7	1.6	.0
Devils Lake	1,478	11	44	28.43	30.06	.00	23.6	−.9	51	29	32	−10	19	15	50	20	18	88	.77	.0	8	7,864	nw.	35	nw.	20	4	10	16	7.3	4.5	.2
Ellendale	1,457	10	56	28.46	30.07		28.0		62	24	40	−7	19	16	42				.15	−.6	4	10,869	nw.	38	nw.	10	6	8	16	6.6	1.9	.0
Grand Forks	833	12	67				23.2		50	3	31	−13	19	15	42	20			.88		9		se.	38	nw.	11	2	12	16		6.5	2.2
Williston	1,878	41	48	28.03	30.07	+.01	26.6	−.6	50	4	35	−7	14	18	35	24	20	79	.62	.0	5	5,708	sw.	31	nw.	19	8	13	9	5.4	6.2	T.
Upper Mississippi Valley							35.1	−3.3										74	1.75	−.2									5.9		
Minneapolis	918	102	208	29.07	30.08		30.7	−1.7	63	6	39	−5	19	22	29				2.28	+1.0	9	8,555	s.	28	nw.	23	5	11	14	6.7	.8	.0
St. Paul	837	114	149	29.15	30.09	+.03	30.6	−1.9	63	6	39	−3	19	22	32				2.29	+1.0	9	7,082	sw.	24	nw.	22	6	8	16	6.4	1.8	.0
La Crosse	714	11	48	29.32	30.12	+.05	31.7	−3.5	62	6	41	4	19	23	31	28	24	75	1.23	−.3	6	4,798	s.	17	sw.	24	7	7	16	6.7	.7	.0
Madison	974	70	78	29.06	30.15	+.09	32.0	−3.2	58	6	39	7	19	25	23	28	24	75	1.42	−.4	6	7,050	s.	22	s.	22	8	8	14	6.5	.7	.0
Wausau	1,247	4	62	28.74	30.12		28.1		54	6	36	1	19	20	27				2.62	+.8	7	5,369	s.	21	w.	20	5	6	19	7.6	2.8	.0
Charles City	1,015	10	51	29.02	30.14	+.06	30.9	−2.1	62	6	40	3	19	22	33	27	23	77	1.97	+.4	6	6,003	se.	24	se.	22	8	8	14	5.9	.4	.0
Davenport	606	118	143	29.49	30.17	+.09	35.8	−3.2	61	5	45	14	21	27	28	31	26	72	1.28	−.5	6	7,532	sw.	27	sw.	13	11	8	11	5.6	.4	.0
Des Moines	861	5	99	29.22	30.16	+.08	33.2	−5.2	62	30	43	7	19	24	36	29	25	74	2.22	+.8	4	7,260	se.	25	nw.	7	6	9	15	6.4	6.1	T.
Dubuque	700	81	96	29.38	30.16	+.09	33.6	−3.4	60	5	42	10	19	25	28	29	24	73	1.03	−.7	5	5,409	s.	19	n.	18	8	6	16	6.2	.8	.0
Keokuk	614	64	78	29.50	30.20	+.11	37.0	−4.1	63	4	46	12	16	28	30	31	26	70	1.78	−.2	5	6,108	sw.	24	nw.	11	10	12	8	5.1	3.3	.0
Cairo	358	87	93	29.80	30.19	+.07	43.8	−3.5	71	7	52	24	16	35	34	39	34	74	2.65	−1.0	7	6,623	n.	27	n.	26	9	5	16	6.1	1.6	.0
Peoria	609	11	45	29.51	30.19	+.10	36.0	−1.5	64	4	45	16	21	27	30	31	27	78	.94	−1.4	5	5,703	s.	18	w.	11	14	7	9	4.6	5.6	.0
Springfield, Ill.	636	5	191	29.48	30.18	+.08	37.0	−5.2	66	4	46	15	20	29	27	33	29	77	1.32	−1.2	5	8,285	s.	24	s.	13	9	13	8	5.2	7.6	T.
Hannibal	534	74	109	29.60	30.20	+.11	38.0	−4.1	66	14	48	12	16	28	32				1.08	−1.0	5	6,654	sw.	24	sw.	13	10	11	9	5.2	8.0	.0
St. Louis	568	265	303	29.56	30.18	+.08	41.0	−4.1	66	4	50	19	16	32	36	35	29	68	2.08	−.8	5	8,497	s.	31	sw.	14	12	9	9	4.9	5.3	.0
Missouri Valley							37.7	−1.2										62	0.75	−0.6									5.3		
Columbia, Mo	784	6	84	29.33	30.20	+.11	39.1	−4.2	66	14	49	8	16	29	36				1.27	−.9	5	6,238	s.	24	nw.	11	13	9	8	4.7	4.8	.0
Kansas City	963	10	86	29.13	30.19	+.10	40.1	−3.6	67	3	50	11	16	31	34	34	27	64	1.49	−.3	7	7,319	se.	32	nw.	7	17	6	7	4.1	6.4	.0
St. Joseph	967	11	49	29.11	30.17		38.0		66	3	48	10	16	28	32	31	24	62	.59	−1.0	3	6,894	se.	28	nw.	7	17	5	8	4.1	1.5	.0
Springfield, Mo	1,324	98	104	28.74	30.18	+.08	41.6	−4.1	70	20	51	8	16	32	38	34	28	66	3.17	+.4	5	7,402	s.	24	nw.	11	18	3	9	4.1	6.8	.0
Iola	984	11	50	29.11	30.19	+.10	42.3	−1.8	67	2	56	4	16	29	44				.93	−.9	3		n.				18	5	7		3.0	.0
Topeka	987	92	107				39.1	−3.7	66	13	50	8	16	28	35				.60	−.9	3	7,011	s.	29	nw.	11	17	5	8	3.5	3.0	.0
Lincoln	1,189	11	81	28.86	30.16	+.08	37.8	−1.3	67	30	48	8	16	27	43	31	23	59	.04	−1.0	2	8,368	s.	35	nw.	11	8	12	10	5.9	.1	.0
Omaha	1,105	115	122	28.95	30.17	+.09	36.6	−1.9	64	13	46	8	19	27	31	30	23	62	.56	−.5	5	7,014	s.	30	nw.	8	11	10	9	5.4	3.6	.0
Valentine	2,598	47	54	27.35	30.14	+.06	37.6	+3.0	74	29	51	4	15	24	47	29	21	58	.01	−.6	1	7,771	w.	29	s.	3	7	9	14	6.1	T.	.0
Sioux City	1,135	94	164	28.88	30.14	+.06	33.6	−1.6	61	6	43	5	19	24	32	28	22	66	.79	−.2	5	9,771	s.	41	nw.	8	4	12	14	6.7	5.9	T.
Huron	1,306	59	74	28.67	30.12	+.04	32.6	+1.1	64	24	44	1	15	22	38	27	20	66	.18	−.4	3	8,471	se.	31	nw.	8	9	8	13	5.7	1.6	.0
Pierre	1,572	70	75	28.38	30.10	+.02	36.4	+2.8	69	29	48	1	15	25	41	29	21	59	.02	−.4	2	7,160	nw.	31	n.	18	8	8	14	6.0	.2	.0
Yankton	1,233	49	57	28.78	30.14	+.06	35.8	+.5	66	6	46	5	15	25	41				.15	−.7	3	7,254	nw.	30	nw.	9	4	12	14	6.9	.3	.0
Northern Slope							36.8	+4.1										64	0.41	−0.3									6.6		
Billings	3,140	5					38.3		66	19	51	8	15	26	42				.38		6		nw.				2	12	16		T.	.0
Havre	2,505	11	67	27.35	30.06	+0.03	31.6	+.4	60	30	42	−10	14	21	45	27	22	73	.71	+.1	8	6,923	sw.	42	sw.	5	5	11	14	6.5	9.6	.0
Helena	4,124	89	113	25.81	30.06	+.04	40.0	+6.8	63	19	48	8	14	32	38	33	25	58	.40	−.3	7	6,286	sw.	39	sw.	21	0	11	19	7.6	1.2	.0
Kalispell	2,973	48	56	26.95	30.06	−.01	37.4	+5.0	59	19	44	22	24	31	26	34	31	82	1.34	0	13	3,824	nw.	32	w.	19	0	12	18	8.0	2.5	.0
Miles City	2,371	48	55	27.51	30.13	+.06	34.5	+3.6	60	24	44	−3	15	25	40	29	24	72	.16	−.4	6	4,600	s.	27	nw.	7	6	10	14	6.3	.7	.0
Rapid City	3,259	50	58	26.63	30.12	+.04	40.2	+4.3	75	24	53	10	14	28	49	32	23	57	.06	−.4	4	6,363	nw.	37	nw.	10	7	9	14	6.2	.5	.0
Cheyenne	6,088	84	101	24.05	30.12	+.05	38.9	+4.1	64	28	50	9	23	27	37	30	19	50	.20	−.3	4	10,058	w.	45	w.	13	7	16	7	5.3	1.1	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, November, 1932*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Northern Slope—Continued																															
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Lander	5,372	60	68	24.70	30.16	+0.06	36.8	+6.5	64	19	50	8	11	23	37	28	20	58	0.12	−0.5	2	4,255	sw.	34	sw.	6	5	19	6	5.6	1.1	0.0
Sheridan	3,790	10	47	26.12	30.10	------	36.2	------	66	19	48	8	11	24	41	30	25	76	.61	.0	8	3,787	nw.	26	nw.	21	4	13	13	6.7	5.0	.0
Yellowstone Park	6,241	11	48	23.95	30.20	+.09	32.2	+2.9	53	29	40	4	11	24	28	27	20	62	.46	−.8	9	6,718	sw.	32	sw.	13	0	10	20	8.1	10.2	.0
North Platte	2,821	11	51	27.15	30.14	+.06	39.8	+3.2	71	13	53	14	15	26	43	30	20	56	T.	−.5	0	6,054	w.	28	nw.	8	9	10	11	5.6	T.	.0
Middle Slope							42.6	−.2										54	.23	−.8									3.6		
Denver	5,292	106	113	24.79	30.11	+.05	44.0	+4.2	71	19	57	10	11	31	35	33	21	45	.59	.0	3	5,580	s.	32	n.	9	13	10	7	4.5	5.3	.0
Pueblo	4,685	80	86	25.37	30.14	+.09	42.2	+2.8	75	19	58	7	11	26	51	33	22	52	.30	−.1	3	4,635	n.	32	nw.	13	14	10	6	4.6	2.4	.0
Concordia	1,392	50	58	28.68	30.20	+.12	39.6	−1.8	68	30	50	11	16	29	42	32	24	58	.04	−1.0	1	6,762	s.	31	n.	8	15	9	6	4.1	T.	.0
Dodge City	2,509	10	86	27.52	30.18	+.11	41.8	−.8	73	13	56	10	16	28	43	32	24	58	.15	−.6	3	8,645	s.	31	ne.	14	20	6	4	2.8	.5	.0
Wichita	1,358	85	93	28.71	30.18	+.10	42.4	−2.4	68	30	54	12	16	31	39	34	24	54	.18	−1.2	1	8,134	s.	27	n.	14	16	7	7	4.0	T.	.0
Oklahoma City	1,214	10	47	28.87	30.18	+.10	45.8	−3.0	73	20	57	14	16	34	40	37	28	56	.10	−1.8	2	7,327	s.	29	n.	15	24	3	3	1.8	T.	.0
Southern Slope							50.1	−1.7										54	.36	−.7									2.7		
Abilene	1,738	10	52	28.34	30.18	+.11	51.4	−2.1	81	20	65	19	16	38	44	40	29	50	.01	−1.3	1	6,808	s.	26	sw.	14	20	5	5	2.8	T.	.0
Amarillo	3,676	10	49	26.36	30.15	+.10	47.1	+1.6	80	14	61	18	16	33	49	34	22	44	.02	−.9	1	6,931	s.	28	nw.	7	20	7	3	3.0	T.	.0
Big Spring	2,537	5	62	27.52	30.19	------	49.6	------	82	7	64	18	16	35	44	38	29	57	.07	------	1	------	s.	------	------	------	18	9	3	2.9	.0	.0
Del Rio	944	64	71	29.14	30.15	+.10	54.6	−5.4	80	7	67	31	12	42	40	46	39	65	1.40	+.2	3	5,547	se.	27	n.	7	20	4	6	3.0	.0	.0
Roswell	3,566	75	85	26.49	30.15	+.12	47.2	−.9	79	20	63	21	12	31	49	37	27	53	T.	−.8	0	4,819	s.	40	ne.	7	23	5	2	1.9	.0	.0
Southern Plateau							52.3	+3.0										43	T.	−.5									1.7		
El Paso	3,778	152	175	26.30	30.12	+.12	53.2	+.5	77	2	67	31	12	39	35	40	27	40	.00	−.5	0	5,729	e.	38	ne.	10	28	1	1	1.0	.0	.0
Albuquerque	4,972	51	66	25.17	30.13	------	44.4	------	71	2	60	21	25	28	40	33	20	43	.00	------	0	3,013	ne.	20	nw.	7	23	4	3	2.0	.0	.0
Santa Fe	7,013	38	53	23.33	30.17	+.14	40.0	+1.1	62	29	53	14	11	27	35	29	17	44	T.	−.7	0	4,284	e.	19	nw.	10	21	7	2	2.2	T.	.0
Flagstaff	6,907	10	59	23.45	30.11	+.09	40.4	+5.8	67	13	58	14	24	23	46	30	----	58	.00	------	0	5,472	n.	25	ne.	17	17	12	1	----	.0	.0
Phoenix	1,108	10	107	28.86	30.01	+.03	63.0	+3.3	86	5	80	40	12	46	39	47	32	38	.00	−.7	0	3,532	e.	16	e.	24	24	5	1	1.9	.0	.0
Yuma	141	9	54	29.87	30.02	+.04	64.7	+2.3	84	18	79	42	14	50	38	49	33	35	T.	−.3	0	4,066	n.	22	n.	11	26	2	2	1.5	.0	.0
Independence	3,957	6	27	26.10	30.17	+.12	52.3	+5.1	78	18	68	29	4	37	40	37	----	----	.00	−.3	0	------	nw.	----	------	----	22	5	3	----	.0	.0
Middle Plateau							42.7	+3.5										46	.19	−.6									4.0		
Reno	4,532	74	81	25.59	30.15	+.04	46.4	+5.4	72	19	61	23	3	32	43	37	26	48	.02	−.6	1	4,376	sw.	32	sw.	2	18	6	6	3.4	.0	.0
Tonopah	6,090	12	20	------	------	------	47.4	------	64	12	57	28	3	38	29	34	20	36	0	------	0	------	se.	------	------	------	------	------	------	------	------	------
Winnemucca	4,344	18	56	25.75	30.20	+.06	42.0	+3.6	69	1	59	15	3	25	50	33	22	51	.10	−.6	2	5,685	sw.	27	sw.	5	14	9	7	4.1	T	.0
Modena	5,473	10	46	24.74	30.16	+.08	41.0	+4.6	68	20	58	14	11	24	46	30	16	44	.04	−.6	1	6,541	w.	32	s.	2	17	7	6	3.4	.0	.0
Salt Lake City	4,360	163	203	25.77	30.19	+.07	45.0	+3.9	67	1	54	26	11	36	27	36	26	50	.79	−.6	5	4,633	nw.	28	se.	30	11	10	9	5.1	T.	.0
Grand Junction	4,602	60	68	25.54	30.19	+.11	39.3	0	61	18	53	15	11	25	38	30	19	50	T.	−.6	0	3,485	n.	18	nw.	10	15	9	6	4.0	T.	.0
Northern Plateau							43.0	+3.7										69	1.74	+.3									7.6		
Baker	3,471	48	53	26.56	30.20	+.04	39.4	+3.4	61	17	48	22	23	31	29	34	28	67	.96	−.1	9	4,345	se.	27	sw.	2	3	7	20	7.5	3.3	.0
Boise	2,739	79	87	27.32	30.22	+.05	42.7	+1.7	68	29	52	27	11	34	32	37	31	68	1.48	+.2	10	3,763	se.	24	se.	29	4	6	20	7.7	.1	.0
Lewiston	757	40	48	29.31	30.12	0	45.6	+4.2	67	19	54	31	11	38	25	----	----	----	2.68	+1.0	13	3,290	e.	27	nw.	29	2	3	25	8.5	.0	.0
Pocatello	4,477	60	68	25.60	30.19	+.05	40.7	+4.0	63	29	51	18	24	30	33	34	24	53	.25	−1.6	4	7,739	se.	32	sw.	6	3	14	13	6.7	.2	
Spokane	1,929	101	110	28.00	30.09	−.01	42.0	+3.5	58	29	48	26	24	36	19	39	36	80	2.59	+.5	16	5,282	sw.	27	sw.	13	2	8	20	8.0	.3	.0
Walla Walla	991	57	65	29.01	30.10	−.03	47.9	+5.1	68	29	55	31	24	41	27	42	37	70	3.07	+1.0	14	4,841	s.	29	w.	13	3	6	21	7.8	.0	.0
Yakima	1,076	58	67	28.92	30.09	------	42.8	+3.9	68	17	52	25	24	34	32	39	34	75	1.13	+.3	13	3,519	w.	27	nw.	19	5	9	16	7.1	T.	.0
North Pacific Coast Region							49.2	+3.0										84	8.55	+2.4									8.4		
North Head	211	11	56	29.80	30.04	−.01	49.6	+1.4	60	27	54	39	30	46	13	48	46	88	13.88	+5.4	24	12,137	s.	63	s.	1	2	10	18	7.8	.0	.0
Port Angeles	29	8	53	------	30.00	------	46.5	------	65	27	52	32	23	41	21	----	----	----	5.41	+1.4	21	3,684	s.	18	sw.	21	1	7	22	----	.0	.0
Seattle	125	215	250	29.89	30.02	−.02	48.8	+3.2	66	27	53	35	23	44	16	46	43	82	8.76	+3.7	22	7,036	s.	36	sw.	21	1	7	22	8.3	.0	.0
Tacoma	194	172	201	29.82	30.04	0	48.3	+3.7	63	28	54	30	10	43	17	----	----	----	8.57	+2.3	22	6,802	s.	38	sw.	17	0	3	27	8.7	.0	.0
Tatoosh Island	86	9	53	29.87	29.96	−.01	48.8	+2.9	61	27	52	42	21	46	17	46	44	86	15.63	+3.7	27	11,954	e.	63	s.	1	2	2	26	8.9	.0	.0
Medford	1,329	29	58	28.72	30.16	------	45.9	------	63	1	54	28	23	38	30	44	41	84	3.64	+1.2	16	3,361	n.	35	se.	27	0	11	19	8.1	.0	.0
Portland, Oreg	153	68	106	29.93	30.09	−.01	49.3	+2.5	67	17	55	33	24	44	20	46	44	83	7.88	+1.8	21	4,722	se.	21	sw.	2	1	6	23	8.5	.0	.0
Roseburg	510	75	99	29.57	30.13	+.01	50.4	+4.5	66	1	58	35	10	43	23	47	45	82	4.64	.0	16	3,097	s.	24	se.	28	0	7	23	8.5	.0	.0
Middle Pacific Coast Region							57.6	+3.8										68	1.46	−1.3									4.6		
Eureka	62	73	89	30.08	30.14	+.03	52.6	+1.5	68	8	59	42	23	46	20	50	49	89	5.11	−.1	13	4,491	se.	31	sw.	29	3	11	16	7.0	.0	.0
Red Bluff	330	5	58	29.75	30.11	.00	57.8	+4.0	83	17	70	33	4	46	34	49	40	57	.49	−2.5	6	4,862	nw.	25	se.	2	13	6	11	5.1	.0	.0
Sacramento	69	106	117	30.03	30.10	+.01	59.0	+5.4	84	17	70	38	3	47	32	51	43	59	.36	−1.5	5	4,794	nw.	23	nw.	16	20	7	3	2.4	.0	.0
San Francisco	155	208	243	29.94	30.11	+.02	60.6	+4.3	82	17	68	49	21	53	25	53	47	67	1.00	−1.4	7	3,980	w.	24	s.	29	15	7	8	4.3	.0	.0
San Jose	141	12	110	29.96	30.12	------	58.0	+3.6	84	17	70	35	4	46	35	----	----	----	.36	−1.1	3	3,843	nw.	21	se.	29	14	6	10	4.2	.0	.0
South Pacific Coast Region							64.4	+6.1										54	.20	−.8									3.0		
Fresno	327	89	98	29.75	30.11	+.05	60.0	+5.8	83	19	73	40	3	46	34	49	38	52	.30	−.6	1	3,338	nw.	22	nw.	2	19	5	6	2.9	.0	.0
Los Angeles	338	159	191	29.69	30.05	+.03	69.0	+8.1	91	8	80	49	14	58	33	53	40	45	.00	−1.2	0	4,045	ne.	15	ne.	24	21	7	2	2.5	.0	.0
San Diego	87	62	70	29.93	30.02	.00	64.2	+4.5	87	24	74	49	15	55	27	55	48	64	.30	−.5	1	3,563	nw.	16	nw.	28	18	6	6	3.5	.0	.0
West Indies																															
San Juan, P. R	82	9	54	29.81	29.89	------	79.2	+.8	90	11	84	71	27	74	15	----	----	----	5.84	−.9	20	6,497	e.	29	e.	1	2	23	5	5.9	.0	.0
Panama Canal																															
Balboa Heights	118	6	97	------	[1] 29.82	.00	78.6	−.5	89	24	84	71	4	73	15	----	----	[1] 87	10.18	−.1	24	5,716	nw.	33	s.	6	0	4	26	8.5	.0	.0
Cristobal	36	6	97	------	[1] 29.82	.00	79.7	+.4	91	4	84	72	29	75	16	75	74	[1] 85	37.13	+15.6	24	7,864	n.	34	nw.	29	0	7	23	8.4	.0	.0
Alaska																															
Fairbanks	455	11	44	[2] 29.36	[2] 29.94	------	−8.2	------	19	25	0	−30	15	−17	33	−7	−11	79	.30	------	8	1,883	n.	14	ne.	21	16	2	12	4.6	6.1	7.9
Juneau	80	11	50	[2] 29.58	[2] 29.67	------	31.8	------	43	25	35	11	14	28	11	29	23	70	7.05	------	22	6,872	w.	29	e.	17	2	2	26	8.7	25.1	4.5
Hawaiian Islands																															
Honolulu	38	86	100	[2] 29.97	[2] 30.01	------	75.4	+0.9	83	6	80	67	28	71	12	69	66	73	2.14	−1.7	15	6,295	e.	26	ne.	28	7	10	13	6.3	.0	.0

[1] Observations taken hourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, November, 1932*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, N. F.	99												
Sydney, C. B. I.	48												
Halifax, N. S.	88												
Yarmouth, N. S.	65												
Charlottetown, P. E. I.	38												
Chatham, N. B.	28												
Father Point, Que.	20	30.14	30.16	+0.20	27.1	−1.8	33.6	20.7	50	4	2.39	−0.72	16.2
Quebec, Que.	296	29.86	30.20	+.18	26.8	−2.2	32.4	21.1	49	−4	4.17	+.41	29.7
Doucet, Que.	1,236				17.5		27.6	7.4	44	−35	3.73		32.3
Montreal, Que.	187	29.96	30.18	+.15	31.6	−.2	37.9	25.4	54	4	4.96	+1.22	12.0
Ottawa, Ont.	236	29.92	30.20	+.18	30.7	−1.0	38.9	22.6	60	2	3.16	+.62	14.4
Kingston, Ont.	285	29.87	30.19	+.15	35.9	+.9	42.8	29.0	56	6	4.02	+.78	1.8
Toronto, Ont.	379	29.77	30.19	+.15	35.7	+.1	42.1	29.3	59	8	4.04	+.90	7.8
Cochrane, Ont.	930				20.8		28.1	13.5	45	−12	3.27		28.0
White River, Ont.	1,244	28.68	30.04	+.06	19.4	−1.1	30.2	8.7	47	−23	2.71	+.86	24.8
London, Ont.	808				33.1		40.4	25.8	58	7	3.38		7.0
Southampton, Ont.	656	29.42	30.16	+.14	34.3	−.7	41.3	27.4	58	9	2.38	−1.32	3.5
Parry Sound, Ont.	688	29.44	30.16	+.15	31.4	−.7	37.8	25.0	53	2	3.41	−.96	10.4
Port Arthur, Ont.	644	29.33	30.06	+.06	25.7	+1.7	34.1	17.3	50	−9	3.73	+2.40	13.0
Winnipeg, Man.	760	29.21	30.08	+.04	18.5	+.5	26.3	10.7	46	−20	2.40	+1.32	20.4
Minnedosa, Man.	1,690	28.16	30.06	+.02	17.0	−.3	25.5	8.6	48	−13	1.01	+.01	8.5
Le Pas, Man.	860				11.0		18.7	3.2	50	−25	.93		9.3
Qu'Appelle, Sask.	2,115	27.68	30.01	+.01	18.6	−.2	25.7	11.5	46	−13	2.26	+1.37	22.6
Moose Jaw, Sask.	1,759				22.5		30.4	14.5	55	−8	.76		6.9
Swift Current, Sask.	2,392	27.38	29.90	−.03	24.4	+1.2	32.2	16.6	55	−8	.90	+.21	8.3
Medicine Hat, Alb.	2,365	27.41	29.94	−.06	29.7	+2.3	37.9	21.6	60	−15	1.05	+.13	8.7
Calgary, Alb.	3,540	26.17	29.95	−.03	27.3	+1.5	36.2	18.4	53	−10	.80	−.08	8.0
Banff, Alb.	4,521												
Prince Albert, Sask.	1,450	28.43	30.07	+.04	15.9	+.5	24.3	7.6	51	−12	.72	−.11	7.2
Battleford, Sask.	1,592	28.24	30.05	+.03	17.7	+1.4	26.1	9.4	52	−9	.33	−.25	3.3
Edmonton, Alb.	2,150	27.58	29.93	−.04	21.1	−1.8	28.7	13.5	52	−12	1.54	+.96	15.4
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.74	29.99	.00	46.7	+3.5	50.0	43.5	59	38	7.45	+.48	.0
Barkerville, B. C.	4,180												
Estevan Point, B. C.	20												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.92	30.08	+.03	70.2	+1.5	74.5	65.9	82	60	11.26	+6.88	.0

LATE REPORTS FOR OCTOBER, 1932

Sydney, C. B. I.	48	29.97	30.02	+0.06	49.8	+3.3	57.5	42.1	74	28	3.66	−1.03	0.0
Halifax, N. S.	88	29.92	30.03	+.03	50.9	+3.7	58.2	43.5	72	30	3.05	−2.50	.0
Yarmouth, N. S.	65	29.92	29.99	−.03	52.5	+4.9	59.7	45.3	76	31	2.46	−1.66	.0
Charlottetown, P. E. I.	38	29.90	29.94	−.02	50.8	+4.3	56.5	45.1	71	33	2.27	−2.63	T.
Chatham, N. B.	28	29.84	29.87	−.09	47.7	+4.7	56.6	38.9	75	24	4.01	+.15	.0
Medicine Hat, Alb.	2,365	27.46	29.97	.00	40.5	−4.3	49.8	31.3	78	11	.86	+.28	4.2
Calgary, Alb.	3,540	26.26	29.98	+.03	37.2	−2.9	46.4	28.0	79	1	.85	+.37	7.7
Banff, Alb.	4,521	25.37	30.00	+.05	35.3	−4.0	43.1	27.5	68	5	2.96	+1.94	14.8
Edmonton, Alb.	2,150	27.65	29.96	+.03	36.2	−4.9	44.5	28.0	80	10	.50	−.20	4.4
Kamloops, B. C.	1,262	28.71	30.02	+.05	46.5	−.5	53.8	39.3	75	24	.98	+.37	T.
Estevan Point, B. C.	20				49.2		53.7	44.8	65	35	12.53		.0
Prince Rupert, B. C.	170				48.3		53.7	42.9	67	34	12.88		.0
Hamilton, Ber.	151	29.90	30.06	+.04	73.5	+.5	78.3	68.7	84	61	5.32	−1.39	.0

SEVERE LOCAL STORMS, NOVEMBER, 1932

(Compiled by Mary O. Souder)

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Philadelphia, Pa., and vicinity.	1	A. m.				Wind and rain	Telephone and telegraph lines disabled; some other property damaged.	Official U. S. Weather Bureau.
Jamaica Bay section, Long Island, and New York City, N. Y.	1					Gale	Much damage to property; more than 50 persons injured.	Do.
Havre, Mont. (vicinity)	5				$350	Wind	Some property damage	Do.
Baltimore, Md., and vicinity.	9				10,000	Gale and heavy rain.	Navigation on Chesapeake Bay and passenger airplane traffic interrupted; property damaged.	Do.
Sandy Hook, N. J.	9					Gale	Sea wall and houses along water front seriously damaged because of high tides.	Do.
Wilkes-Barre, Pa.	9					Wind	House blown down; trees uprooted	Do.
Philadelphia, Pa., and vicinity.	9–10			4		Heavy rain and severe gale.	Traffic delayed; buildings damaged; many large trees uprooted.	Do.
Scranton, Pa., and vicinity.	9–10					Gale	Electric wires blown down; trees uprooted; much property damage.	Do.
Tompkins, Cortland, and Brown Counties, N. Y.	9–10					Wind	Telephone and power lines damaged; houses unroofed; barns blown down and trees uprooted.	Do.
New Haven, Conn., and vicinity.	10				175,000	Wind and rain	Highest tide in 16 years caused considerable damage; cars stranded; cellars flooded in houses along water front.	Do.
Narragansett Bay, R. I., region.	10				50,000	Gale	Shore dwellings swept out to sea by high tides; sea craft considerably damaged.	Do.
Fort Wayne, Ind.	15–16					Snowstorm	Traffic blocked; several accidents occurred because of slippery pavements.	Do.
Indianapolis, Ind.	15–16					Snow and ice	Cars stalled and traffic difficulties continued all day.	Do.
Detroit, Mich.	15–16				1,000	Snowstorm	Building collapsed	Do.
Toledo, Ohio	15–16					do	All transportation interrupted; huge tent covering market collapsed.	Do.
Mason City, Iowa	22					Glaze	Power lines and poles damaged	Do.
Garden, Mich., to Milwaukee, Wis.	25	P. m.		2		Wind	Crew lost when small vessel foundered on northern Lake Michigan.	Do.
Grand Marais, Mich.	25			5		do	Fishing boat capsized at entrance to channel; entire crew lost.	Do.
Jacksonville, Fla., and vicinity.	26–30				$500,000	Wind and storm tides.	Highest tides in 20 years washed away bulkheads, damaging docks and other structures.	Do.
Wrightsville Beach, N. C.	26–28				15,000 to 20,000	Wind	Damage to buildings	Do.
Havre, Mont., and vicinity.	30				150	do	Property damaged	Do.

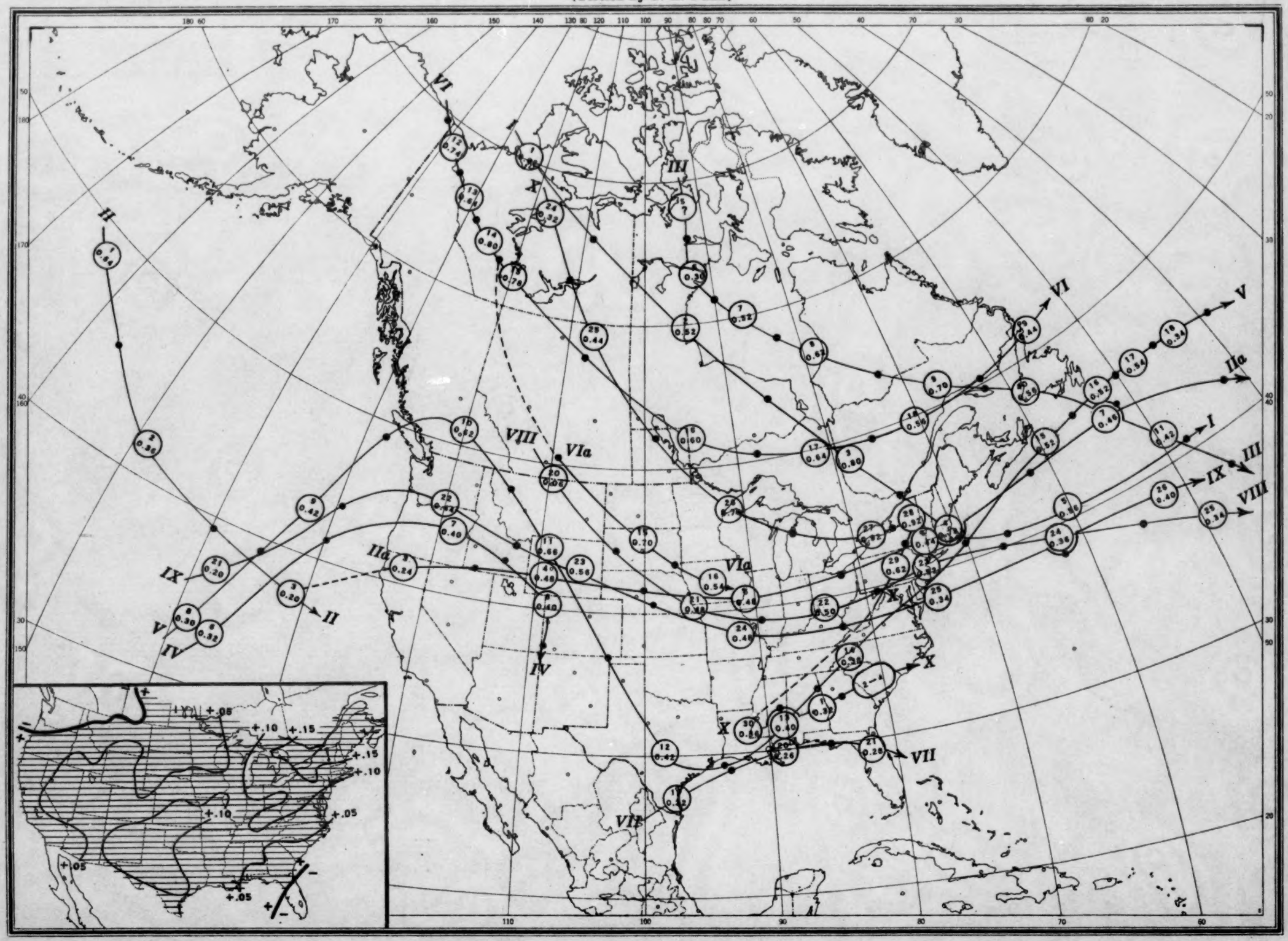
Chart I. Departure (°F.) of the Mean Temperature from the Normal, November 1936

Chart I. Departure (°F.) of the Mean Temperature from the Normal, November, 1932

Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, November, 1932. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, November, 1932. (Inset) Change in Mean Pressure from Preceding Month

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, November, 1932. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by G. E. Dunn)

November, 1932. M. W. R.

LX—87

Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

FROM U.S. WEATHER BUREAU

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, November, 1932

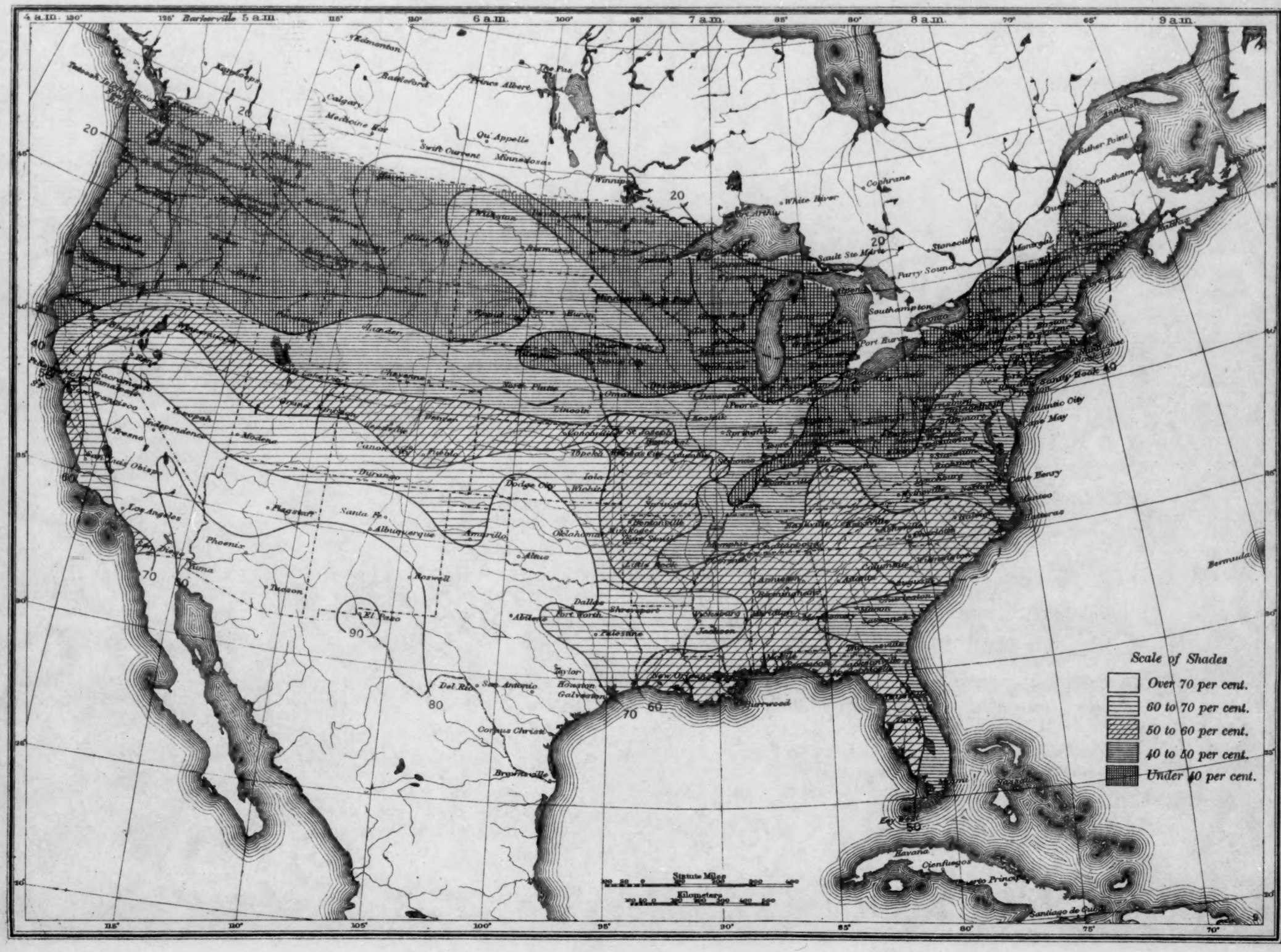
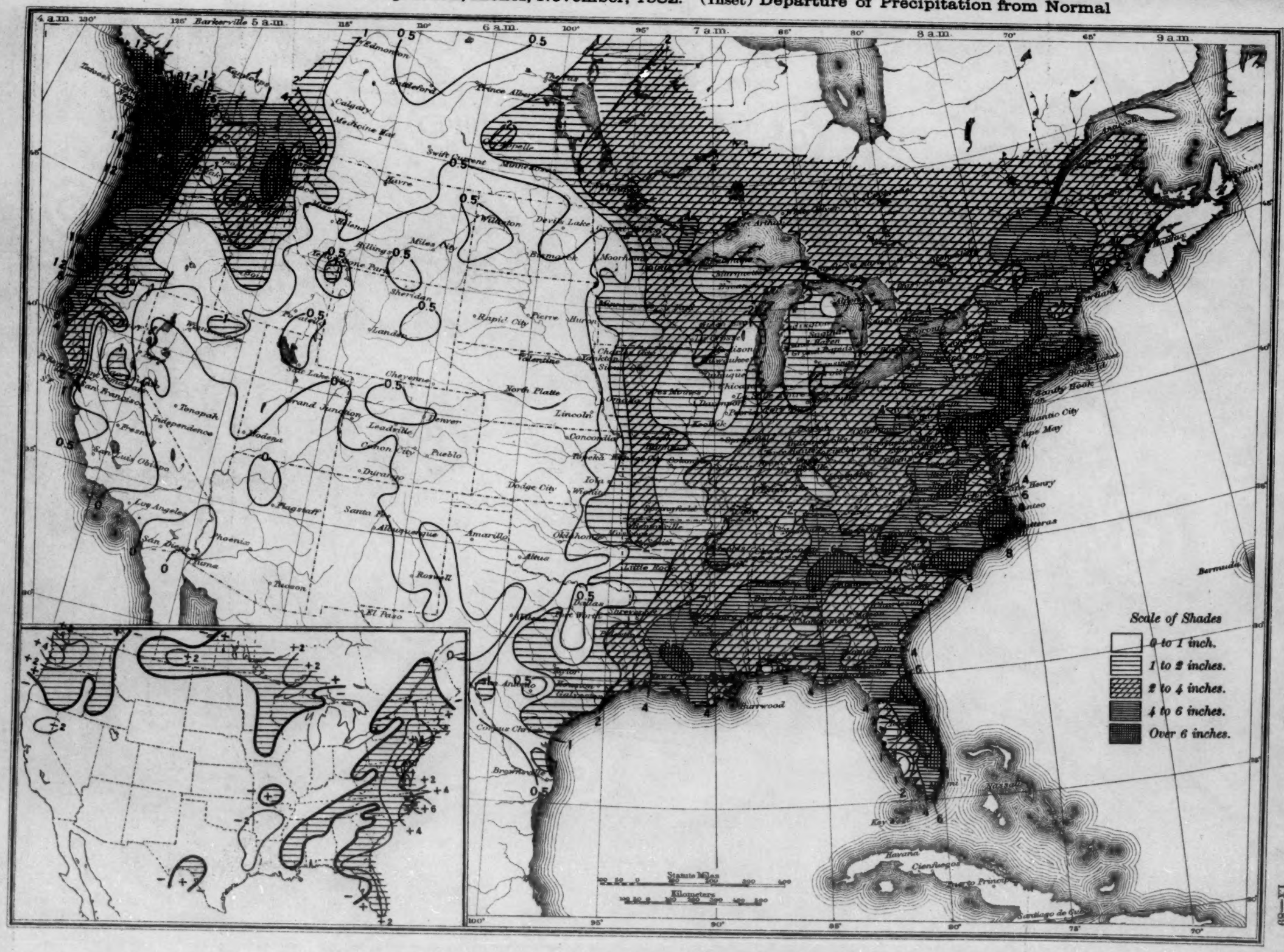


Chart V. Total Precipitation, Inches, November, 1932. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, November, 1932. (Inset) Departure of Precipitation from Normal



November, 1932. M. W. R.

LX—69

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, November, 1932

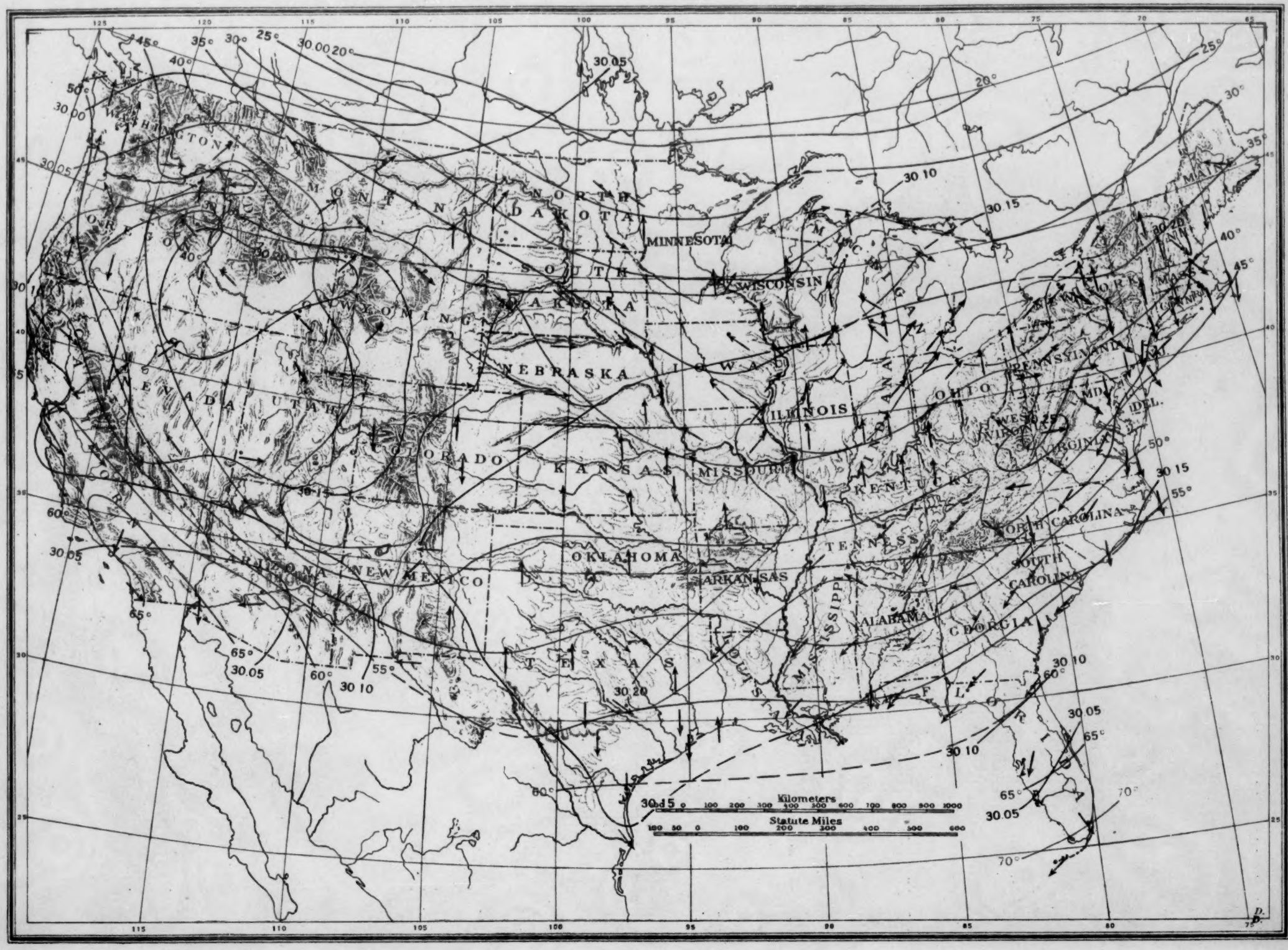


Chart VII. Total Snowfall, Inches, November, 1932. (Inset) Depth of Snow on Ground at end of Month

Chart VII. Total Snowfall, Inches, November, 1932. (Inset) Depth of Snow on Ground at end of Month

November, 1932. M. W. R.

Chart VIII. Weather Map of North Atlantic Ocean, November 7, 1932

Chart VIII. Weather Map of North Atlantic Ocean, November 7, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)

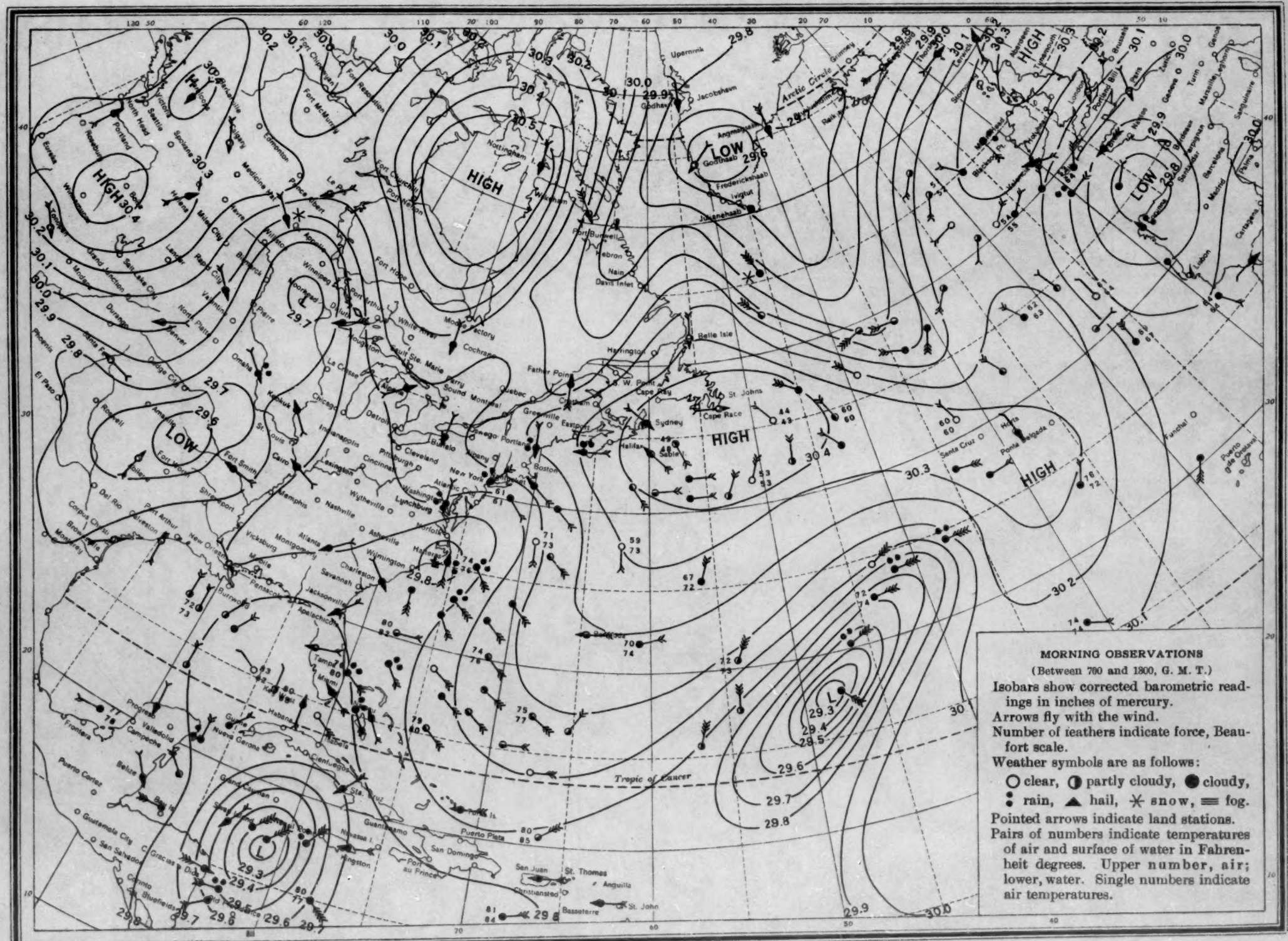


Chart IX. Weather Map of North Atlantic Ocean, November 9, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)

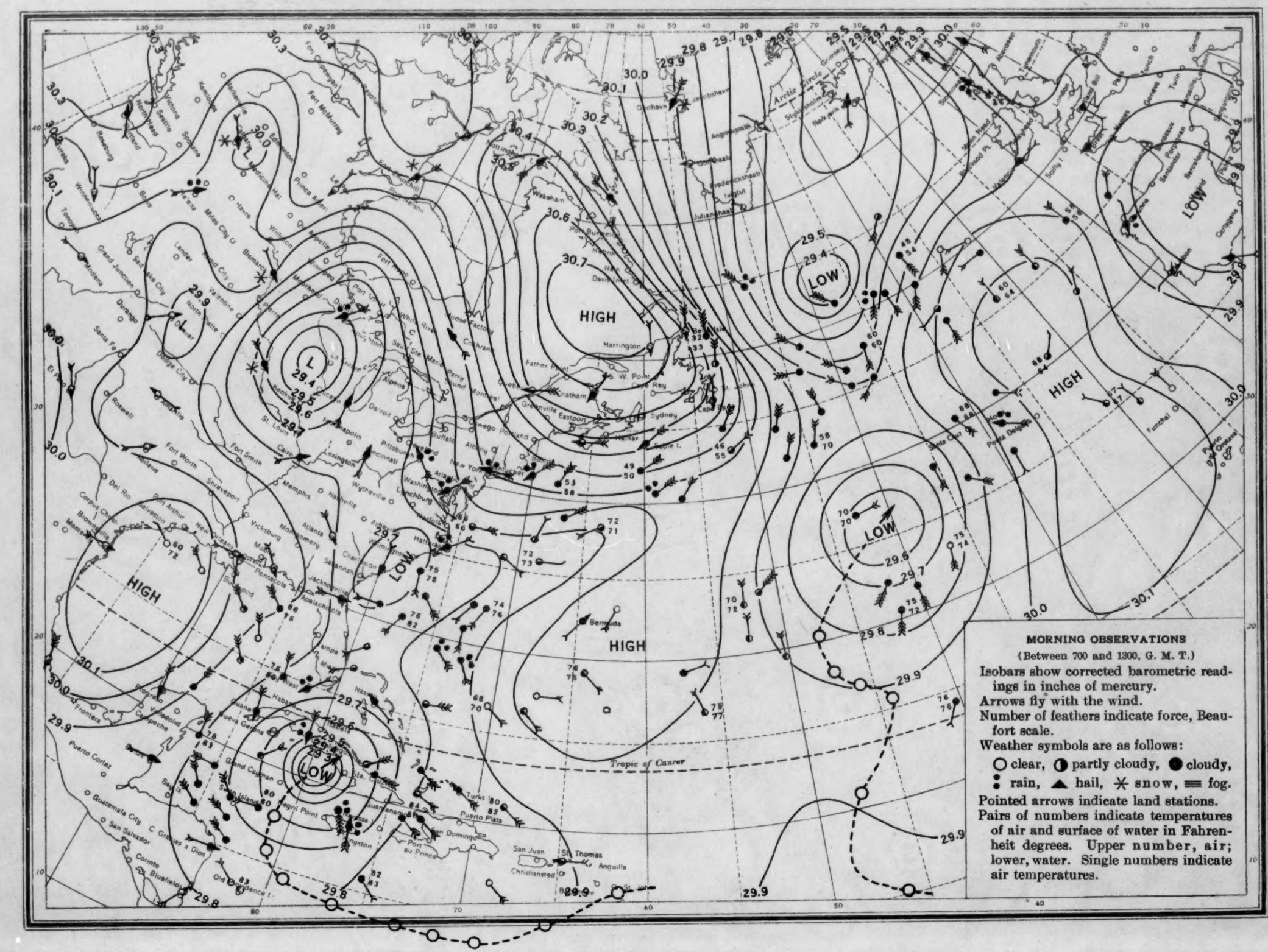
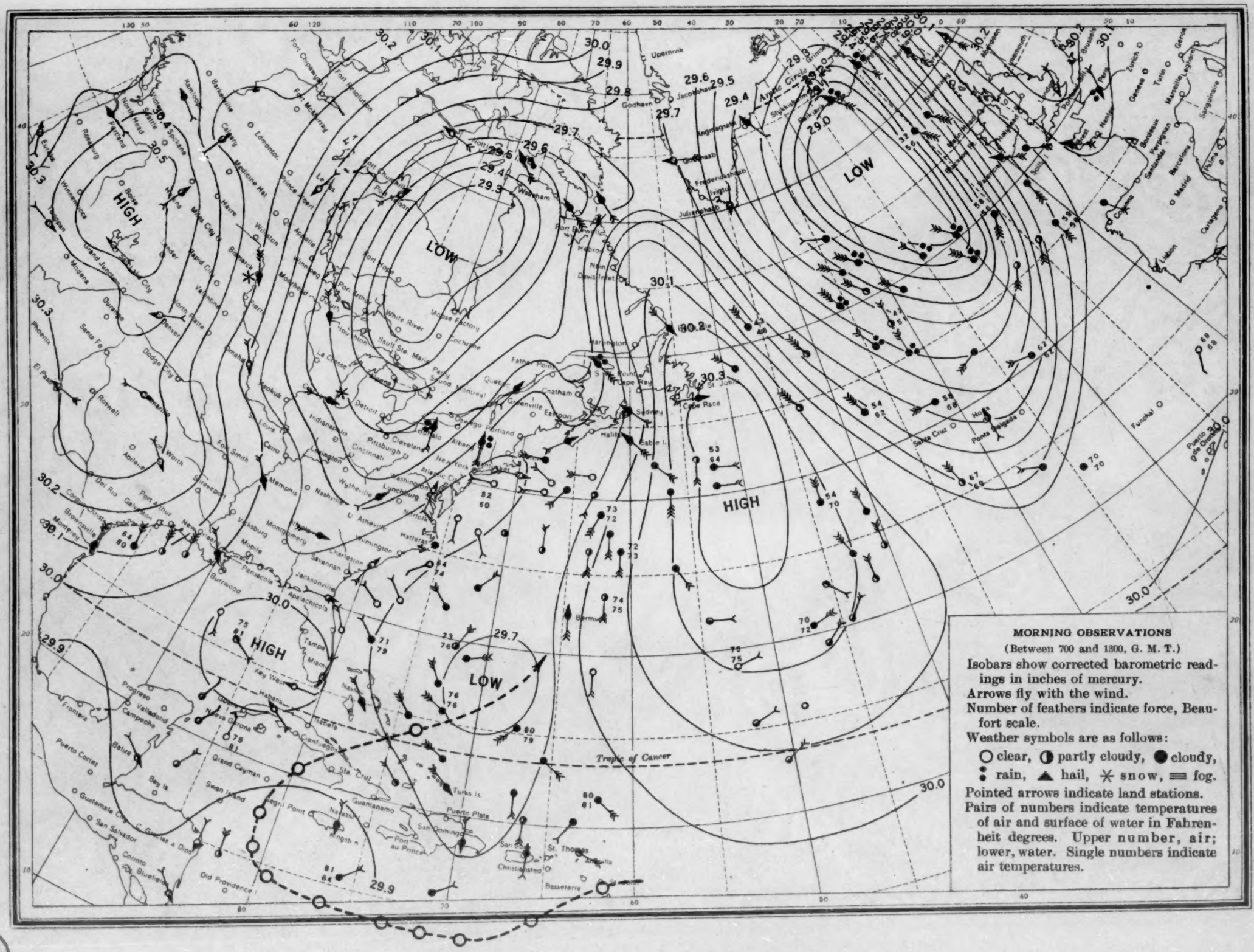

HIGH
LOW
HIGH
LOW
HIGH
LOW
HIGH
LOW
Arctic Circle
Tropic of Cancer
MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
○ clear, ◑ partly cloudy, ● cloudy,
⋮ rain, ▲ hail, ✳ snow, 〓 fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart X. Weather Map of North Atlantic Ocean, November 11, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart X. Weather Map of North Atlantic Ocean, November 11, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

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○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

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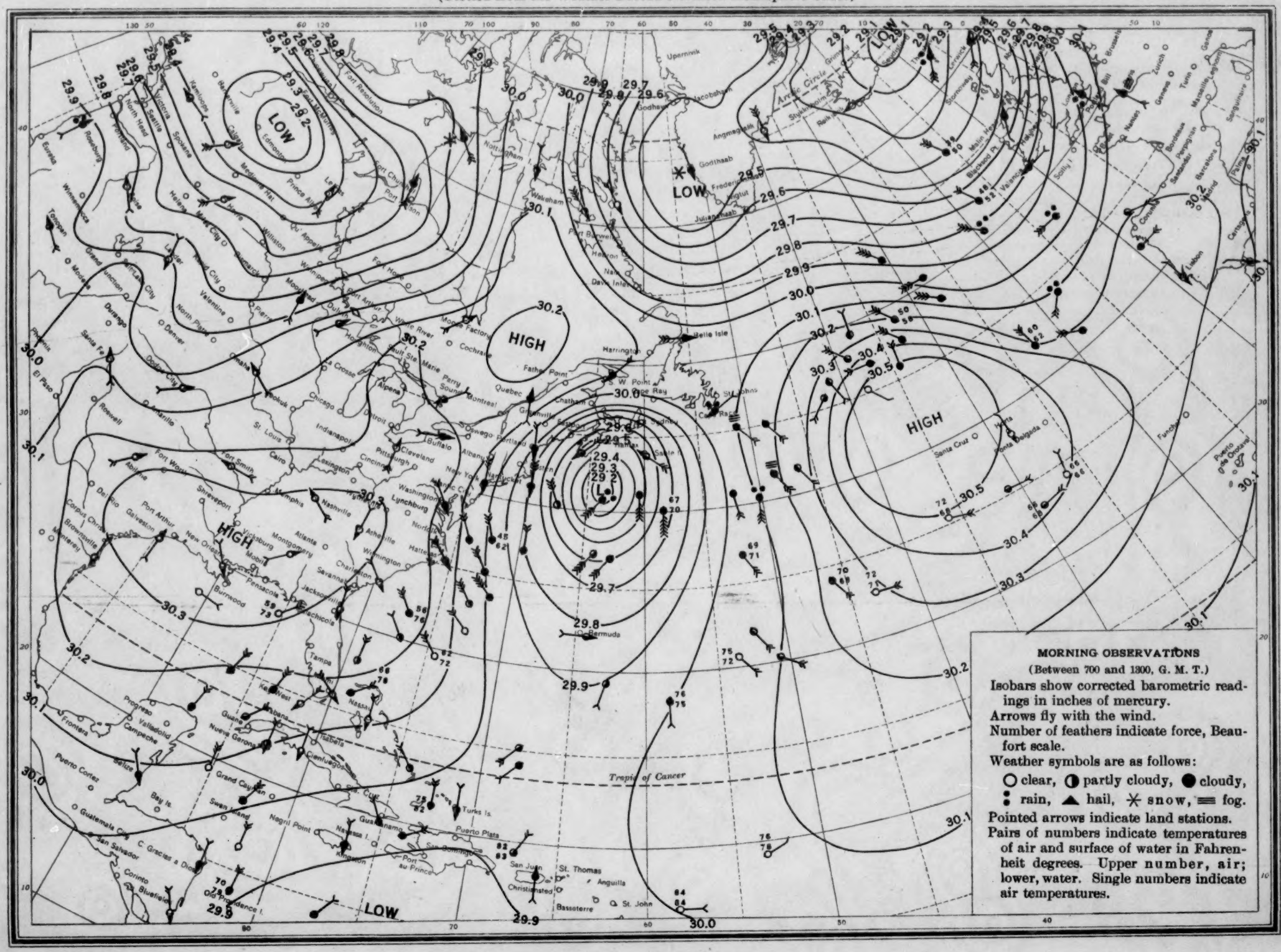
Chart XI. Weather Map of North Atlantic Ocean, November 30, 1932

(Plotted from the Weather Bureau Northern Hemisphere Chart)


LOW
HIGH
LOW
HIGH
LOW
Tropic of Cancer
MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)
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